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THE JOURNAL

OF

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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For Sale—6-inch Newtonian Reflecting Telescope (see illustration in this JOURNAL page 341, October 1939.) This telescope with aluminised mirror, duraluminum tripod and altazimuth mounting, weighs only 35 lbs. Eyepieces with 50x and 100x magnification. A highly accurate, well finished, but very inexpensive telescope. Produced and sold by the Shaw-Hopkins Laboratory, Victoria, B. C.

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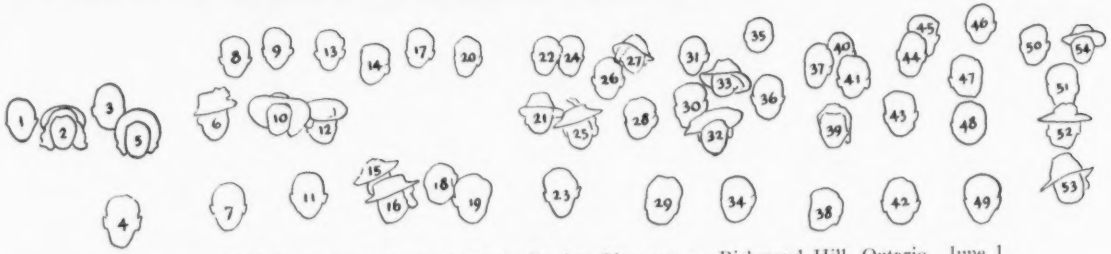

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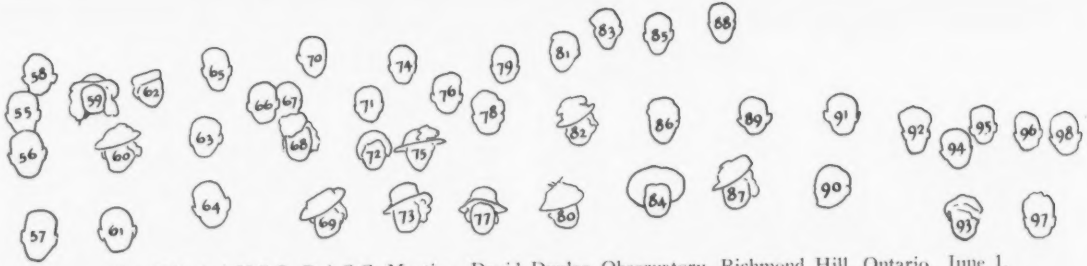

The 1940 A.A.V.S.O.-R.A.S.C. Meeting, David Dunlap Observatory, Richmond Hill, Ontario, June 1.

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THE 1940 A.A.V.S.O. SPRING MEETING IN TORONTO

(with Plate X)

FOR the first time in its nearly thirty years of existence, the American Association of Variable Star Observers held its spring meeting on foreign soil, though still in the Americas. This memorable affair was held by the invitation of the Toronto Centre of the Royal Astronomical Society of Canada at the University of Toronto and the David Dunlap Observatory on May 31st and June 1st.

To be sure, the R.A.S.C. members far outnumbered the A.A.V.S.O. in attendance, but even so, nearly forty persons travelled about 50,000 miles from the States to Canada and back to attend this meeting.

The session on Friday evening was a strictly R.A.S.C. affair with the A.A.V.S.O. as welcome guests, and at this meeting Dr. John Satterly, Professor of Physics, University of Toronto, gave his popular and exciting demonstration on liquid air; what it can do and the practical uses to which it can be put. The hour and a half demonstration was enlightening and thrilling, with plenty of surprises thrown in. Its very low temperature boiling point makes liquid air capable of performing many seeming miracles.

Mr. S. C. Brown, Chairman of the Toronto Centre, welcomed the A.A.V.S.O. members and explained for the benefit of the non-astronomically inclined persons in the audience, what variable stars are and what value the observation of them has on the solution of cosmic problems.

The sessions on Saturday were held under the auspices of the A.A.V.S.O. at the David Dunlap Observatory at Richmond Hill, and were ably presided over by President Helen Sawyer Hogg, a member of the staff of the David Dunlap Observatory. The morning session dealt with regular business affairs, David B. Pickering acting

as Secretary pro-tem. The reports of the various committees brought out much more constructive discussion than has usually prevailed at previous meetings. This was particularly true of the work of the Nova Search and Auroral Committees.

The Nova Search Committee has made a new and splendid start, with the co-operation of a dozen South African observers, to look after the southern skies. With more than a hundred areas to be assigned, volunteers from other astronomical organizations are desired. No telescope is needed for this work, the unaided eye and clear weather, with a keen knowledge of the brighter stars, being the only requisites to participate in this work.

The work on Auroral observations was explained by Mr. E. A. Halbach, Chairman, and later expanded by Dr. C. H. Gartlein of Cornell University who originated the programme in collaboration with the National Geographical Society. Both visual and photographic observations are planned with the hope that, in a few years, our knowledge of this interesting phenomenon will be greatly augmented.

The papers presented, though not numerous, provoked considerable discussion. Mrs. Margaret Walton Mayall of the Harvard Observatory staff described her discovery and subsequent study of the light curve of a new long-period variable, the one which to date has the longest period yet found for a variable star of this class. She discovered the star through detection of the bright lines visible on a spectrum plate and her observations, covering fifty years, revealed a period of 1380 days, twice as long as that known to exist for any long period variable previously found. There is strong evidence of still-stands near minimum phase. While the average period of the nearly 2000 long period variables is 280 days, approximately nine months, a few such variables have periods around two years in length. The range in brightness is approximately three magnitudes and it is bright enough to be observed in moderately sized telescopes, even though the variations from month to month are relatively slow.

Mr. Clinton B. Ford, now associated with the Ladd Observatory of Brown University, described his new type of photometer, using polaroid as the medium of comparison. In spite of the fact that earlier samples of this material proved rather unsatisfactory, he now feels that the new improved polaroid will be highly successful and

in the near future he hopes to provide an instrument for measuring light variations which will be fruitful of results and relatively inexpensive.

Following luncheon, tendered to the States visitors by the Toronto Centre of the R.A.S.C., and so delightfully served at the United Church in Richmond Hill, the group photograph was taken and then a short, final business session was held in the afternoon.

Mr. L. E. Armfield of the Milwaukee Astronomical Society presented an important paper (which is to be printed in full shortly in this JOURNAL) describing auroral studies and their relation to solar and terrestrial activities as outlined by the leading telephone companies of the country, looking forward to a more complete interpretation of these striking and spectacular phenomena, with the possibility of making in the near future practical predictions of telephonic, telegraphic, and radio disturbances.

Dr. R. K. Young, Director of the Observatory, then welcomed the two associations and explained the general work and equipment of the observatory. After an Observatory Open House during which most of the equipment of the observatory was made available to visitors, everyone drove to Don Alda Farms, some fifteen miles distant, where they were royally received and entertained at tea by Mrs. David Dunlap. Inclement weather necessitated changing the original plans for a garden party, but cordiality and friendliness reigned supreme. His Honour, The Lieutenant Governor of Ontario, and Mrs. Matthews were present, and other notables of governmental and educational circles.

On Saturday evening some 150 members and guests of both organizations gathered at the Great Hall of Hart House for the banquet. Madame President Hogg acted as toastmistress and following toasts to King George and President Roosevelt, further toasts were offered; to the R.A.S.C. by Mr. Charles W. Elmer and responded to by Mr. S. C. Brown; to the A.A.V.S.O. by Professor Frank S. Hogg with response by Mr. David B. Pickering; to the University of Toronto by Dr. Harlow Shapley, with response by the Honourable and Reverend H. J. Cody, President of the University.

Several addresses were made, the first by Recorder Leon Campbell who, in a dreamy sort of fashion, recounted the early formative

days of the A.A.V.S.O., referring to the organizers and first observers including Messrs. Olcott, McAteer, Bouton, Chandra, Yalden, David B. Pickering, Miss Young and others. The second address was given by Dr. C. A. Chant, Director Emeritus of the David Dunlap Observatory, who talked on the early struggles of the R.A.S.C., its beginnings as a local astronomical unit and its gradual extension to a dominion institution with centres in numerous localities. Each centre has its own local officers, but is closely affiliated with the parent body. The purposes of the JOURNAL and *Handbook* were fully described.

Dr. Shapley finished the speaking programme by looking forward to 1950 and predicting what astronomers and astronomy would be doing at that time, providing of course that astronomical research continues in the interim. Among other things, he mentioned (1) the further development of astronomical gadgets, for example, new photographic developers and new sensitization of plates and improved techniques for handling them; the ultra-Schmidt-type telescope and the adaptation of its principle to already existing large telescopes of the world; (2) new theories on the origins of the solar system made possible by further investigations on the smaller bodies in our system, the asteroids, meteors and comets; (3) a better knowledge of the external galaxies throughout metagalactic space by means of surveys with Schmidt telescopes; (4) probably most important of all, our increased knowledge of solar prominences and corona through the further development and use of the coronagraph and similar instruments; and their correlations with terrestrial phenomena. The use of a modified form of coronagraph by the meteorologist was also stressed.

This joint meeting will live long in the memories of all who participated, especially so because it was held at a time when one can little know what lies ahead of the amateur and professional astronomers the world over.

LEON CAMPBELL

Harvard College Observatory
Cambridge, Massachusetts

POETIC INTERLUDE

The following verses, written in the early 20's, were read at the A.A.V.S.O.-R.A.S.C. banquet in the Great Hall of Hart House, June 1, 1940, by D.B.P. to illustrate the fun and fellowship of the variable star observers of long ago. They concern a sandy-bearded mathematician, now passed away, who became famous in the annals of the A.A.V.S.O.

"You are old, Father Red Beard," the young member said,
"And your whiskers are tangled and long,
But you're still shaking cotangents out of your head—
Don't you think at your age it is wrong?"

"Not at all," said the Sage, "Cotangents are fair
If treated with proper decorum;
But beware of the circle that's wound round a square,
And lay off of the Pons Asinorum."

"You are old," said the youth, "and your eyes are too dim
To see anything in the dark;
Yet you wind 'round your telescope, limb after limb—
Pray, how are you finding your mark?"

"That is easy," said Red Beard, "I study a map
Which aids me to set upon Mars
By the glow from my whiskers, which shine in my lap;
Reflecting the light of the stars."

"But the colors must puzzle you," queried the Youth,
"For the red ones, I hear, are contrary;
It must offer a difficult problem, forsooth,
To a fellow so awkward and hairy."

Said the Sage, "Though I'm seemingly awkward and slow,
So were those who have watched them before us;
And the glint from my beard adds a ruddier glow
To the color of Hind's R Leporis."

"But when they're at minimum," parried the Youth,
"Can you see them at all when they're faint?
It's a puzzle to me how you get at the truth
As to whether they are or they ain't."

Said the Sage, "When they're waning it fills us with scorn,
For it seems that they're trying to joke us;
With a shriek I take Taurus, the Bull, by the horn
And throw the blame thing out of focus."

"Pray explain," said the Youth, "do you orient stars
By the use of cross hairs on your finder?
It's a marvel to me how you even see Mars,
Since you surely grow blinder and blinder."

"I need no such aids," said the Sage, as he leered
In a manner convincing but jocular,
"But make use of the uncontrolled hairs of my beard
When they get tangled up with the ocular."

"Pray explain," said the Youth, " how your whiskers assist
In your efforts at good observation?
I should think so much hair, from your eye to your wrist,
Might blot out a whole constellation."

"This hirsute appendage," the Savant replied
"Doesn't aid me great problems to grapple,
But it acts as a screen to successfully hide
The recoil of my red Adam's apple."

"I observe," said the Youth, "that your methods are quaint,
Like those of the Greek, Eratosthenes;
Did his whiskers, like yours, break all bonds of restraint
Reaching down 'till they rippled across the knees?"

"Begone!" said the Sage, "I have had quite enough
To make me desire to mangle you;
Cease to mention my beard in your doggerel stuff,
Or I'll loop it around you and strangle you."

A SIMPLE POLARIZING PHOTOMETER
(Abstract)

By CLINTON B. FORD

Employing special polarizing plates made experimentally by the Polaroid Corporation of Cambridge, Massachusetts, a simple astronomical photometer has been constructed for use in estimating magnitudes of the brighter ($>10^{m}.0$) long-period variables. The individual plates give somewhat more than 40% light transmission in the red spectral region, and were built into a standard Ramsden eyepiece of two-inches focal length.

The polarizer is a semi-circular disk mounted in the focal plane of the eyepiece, thus rendering one half of the field polarized. The analyser is a smaller complete disk placed between the eye-lens and the eye. The latter may be rotated to produce apparent equality of two stars of different brightness in opposite halves of the field, the amount of rotation being read from a six-inch circular protractor mounted on the eyepiece.

Light absorption is still a troublesome factor, but preliminary tests on the Pleiades with the instrument attached to a 12-inch refractor show that it is not difficult to duplicate settings of the analyzer to within 1.5 degrees on the protractor scale. It is expected that a complete calibration will indicate an accuracy of the order of $0^{m}.05$, and that the photometer will be in active operation on long-period variables by the fall of 1940.

The cost of the instrument, excluding the eyepiece, was about 17 dollars, which brings it within the price-range allowed by many amateur pocketbooks.

Ladd Observatory,
Providence, R.I.

SIDELIGHTS ON THE A.A.V.S.O. MEETINGS

THE season of the meetings marked a number of noteworthy anniversaries. May 31 was Dr. Chant's seventy-fifth birthday and the fifth anniversary of the opening of the David Dunlap Observatory. The following week Dr. Chant played a leading role in the celebration of his class reunion—the class of 1890, University College, University of Toronto. This year also marks the completion of the fiftieth year of the corporate existence of the Royal Astronomical Society of Canada and the hundredth anniversary of the founding in Toronto of the first observatory in Canada.

A.A.V.S.O. members were present from eight states—Connecticut, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Rhode Island and Wisconsin. Hamilton, London and Toronto Centres of the R.A.S.C. were represented; the London Centre sent a delegation of eleven members and guests.

Previous meetings have led us to expect the Milwaukee group of astronomers to set an example of motoring almost astronomical distances at almost astronomical velocities. Thus we were not surprised when, at about eleven o'clock Saturday night, after a strenuous day of meetings, they inquired the way to Bert Topham's Observatory. They explained that they did not need to be back to work in Milwaukee (700 miles away) till Monday morning, so they thought they could profitably use a few of their excess hours visiting Topham to arrange auroral work.

Topham was routed out of bed and spent several hours with a group of enthusiasts, demonstrating his equipment, discussing observational problems, and viewing Kodachrome movies of aurora, displayed by Dr. Gartlein in the basement of Topham's home.

Canadians present were particularly proud of the recognition two of our active amateurs—Bert Topham, of Toronto, and Jack Grant, of Orillia—are receiving. These two men are considered perhaps the most diligent amateur auroral observers in the whole joint A.A.V.S.O.—National Geographical Society campaign. In addition to this, Topham is well up on the list of variable star observers, both as to quantity and quality of observations, and

both these observers are outstanding contributions to meteor research.

Much enthusiasm was displayed by members of both societies in regard to the renewed activity of the Nova-search committee. The only member who suggested that observers be warned not to discover too many novae was Mr. David B. Pickering. His very wittily expressed fears were better understood when it was recalled that he is the originator and donor of the Pickering medal, awarded to observers for the visual discovery of novae!

A feature of the luncheon in Richmond Hill was the number and selection of home-made pies that were served. We are puzzled to know how at least one member was qualified to state that "all the kinds of pie were delicious, especially the lemon."

It was greatly regretted that Mrs. David A. Dunlap, who so generously and graciously entertained the members and guests at her home at Don Alda, was unable to be present as the guest of honour at the banquet as she was just recovering from a very severe cold.

It was with considerable foreboding, due to the war situation, that the Toronto Centre undertook to carry on the long-standing plan of having these meetings here this spring. The scientific inspiration received by the local members from the enthusiastic amateur and professional astronomers from the States, and the warm kindness and friendship the visitors showed toward us, made the whole series of meetings a happy and very memorable occasion for us all.

KEY TO PHOTOGRAPH OF 1940 A.A.V.S.O. MEETING

(Plate X)

1. F. S. Hogg
2.
3. W. Inrig
4. B. J. Topham
5.
6.
7. R. N. Mayall, Cambridge, Mass.
8. W. A. Johnson, Albany, N.Y.
9. Dr. T. H. Whitelaw, Guelph, Ont.
10.
11. W. G. Colgrove, London, Ont.
12. Mrs. Burpee
13. L. J. Boss, North Scituate, R.I.
14. L. Burpee
15. Miss Rogers, London, Ont.
16. Mrs. W. G. Colgrove, London, Ont.
17. P. M. Millman
18. Mrs. Pickering, East Orange, N.J.
19. H. Shapley, Cambridge, Mass.
20. R. A. Seely, New York, N.Y.

21. Mrs. McKone, London, Ont.
22. E. E. O'Connor, London, Ont.
23. R. E. Pearce
24. J. J. Neale, New Haven, Conn.
25. Mrs. Magee, London, Ont.
26. G. R. Magee, London, Ont.
27. Mrs. Neale, New Haven, Conn.
28. E. H. McKone, London, Ont.
29. C. W. Elmer, New York, N.Y.
30. C. Reinhardt, Perth, Ont.
31. C. W. Gartlein, Ithaca, N.Y.
32. Miss Reinhardt, Perth, Ont.
33. Miss Livingstone, London, Ont.
34. R. K. Young
35. H. R. Kingston, London, Ont.
36. C. A. Federer, New York, N.Y.
37. L. E. Armfield, Milwaukee, Wis.
38. Mrs. Chant
39. Mrs. Federer, New York, N.Y.
40. J. Lovinus, Milwaukee, Wis.
41.
42. C. A. Chant
43.
44. E. B. Brown, New York, N.Y,
45. C. M. Prinslow, Milwaukee, Wis.
46. C. T. Plummer
47. F. Graham
48. A. W. Smith, Guelph, Ont.
49. L. Campbell, Cambridge, Mass.
50. R. F. Magis, Milwaukee, Wis.
51.
52. Mrs. Best
53. Mrs. Hogg
54. Miss Nutting, Guelph, Ont.
55. D. W. Best
56. R. S. Duncan
57. S. C. Brown
58. G. Hartman, Turbine, Ont.
59. Miss Aspen, Rochester, N.Y.
60. Mrs. Duncan
61. D. B. Pickering, East Orange, N.J.
62. Mrs. Aspen, Rochester, N.Y.
63.
64. F. Hartmann, Springfield, N.Y.
65. A. H. Aspen, Rochester, N.Y.
66. F. L. Harvey
67.
68. Miss Brookstone
69. Mrs. Harvey
70. F. L. Troyer
71. J. W. Orme
72. Miss Fuller
73. Mrs. Brown
74. J. F. Heard
75. Mrs. Orme
76. E. A. Halbach, Milwaukee, Wis.
77. Miss Hoffleit, Cambridge, Mass.
78. C. B. Ford, Providence, R.I.
79. T. H. Mason
80. Miss Budd
81. J. R. Collins
82. Miss Thompson
83. A. F. Bunker
84. Mrs. Heard
85. C. B. Carpenter, Wayne, Mich.
86. Miss Northcott
87. Mrs. Mayall, Cambridge, Mass.
88. G. B. Munro
89. T. E. Coupe
90. O. J. Farrey, Miami, Florida
91. E. H. Jones, Goffstown, N.H.
92. W. T. Patterson, Guelph, Ont.
93. Miss Plumpton
94. F. S. Hogg
95. C. R. Gregory, Scipio Center, N.Y.
96. N. H. Broadhead, Hamilton, Ont.
97. A. G. Plumpton
98. T. G. Glasser, Ithaca, N.Y.

A SIMPLE PLANETARIUM

By V. C. Jones

THE planetarium consists of a clock movement with a 24-hour ring, a globe representing the earth and a transparent celestial sphere upon which sun, moon, planets and stars are represented. It shows the time just as an ordinary clock and also tells the correct time at all time-zones around the world. The sun, moon, planets and stars maintain their correct positions automatically, with slight manipula-

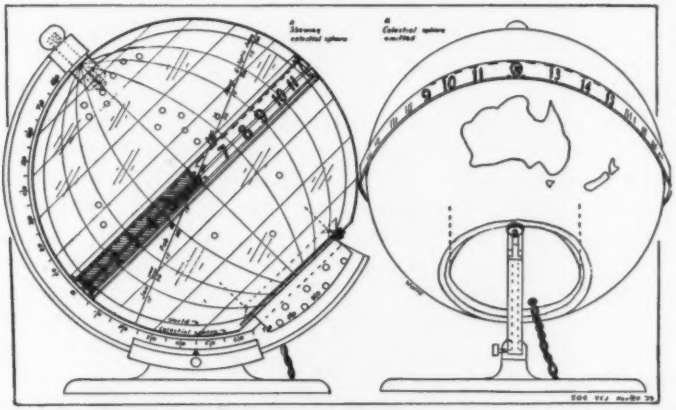


FIG. 1.—Drawings of Planetarium showing, on the left, the complete globe and celestial sphere. On the right the celestial sphere is omitted.

tion for the stars and planets as explained below. It exhibits the universe with all easily visible astronomical objects maintaining their correct positions, and therefore it automatically indicates the time at which astronomical phenomena occur such as rising-time, transit-time and setting-time of any astronomical object; opposition and conjunction of the planets and moon, etc. It is also a ready record of the right ascension and declination of celestial bodies.

Figures 1 and 2 illustrate the planetarium. It consists primarily of a clock movement with an equatorial hour-ring which rotates in the left-to-right direction once in 24 hours. The ring is divided into hours and minutes. Half the ring is shaded to indicate the hemisphere of darkness. The sun symbol is at number 12. (The mean

sun must be on the meridian when the local time is 12 o'clock.) The moon is geared so that it falls back in relation to the hour-ring, losing one revolution in 29½ days. It therefore truly represents the actual moon. As it falls back its age and phase are automatically shown on the time-ring by small figures.

The globe representing the earth is adjusted for local latitude and the north pole is pointed to the north celestial pole, giving

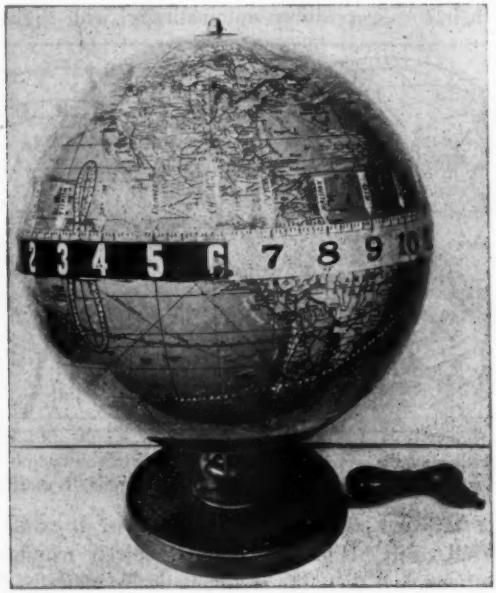


FIG. 2.—Planetarium with celestial sphere omitted.

the planetarium the polar or equatorial mounting as used on all large telescopes. The globe stands still relative to the earth. It therefore turns with the earth while the sun symbol and hour-ring actually stand still relative to the sun. Time zones are suitably named. The instrument shows zone time and local time for any place on the earth.

The hour-ring carries a transparent celestial sphere on which are

marked all visible stars. There are lines on it to represent the equator, declination circles, the ecliptic, and hour circles properly numbered to indicate right ascension. On the ecliptic are shown the signs of the zodiac and the location of the sun for every day in the year. There are movable designations placed on the ecliptic to indicate planets—two for Jupiter and Saturn to be adjusted twice a year, two for Venus and Mars to be adjusted twice a month, and others as desired. The celestial sphere is set by turning it until the sun symbol is on the same meridian as its correct location on the ecliptic according to the day indicated. A slight correction is made by hand once a week by turning the celestial sphere slightly to keep the sun at the right position along the ecliptic. On account of the polar or equatorial mounting all objects are correctly oriented. Sidereal time is shown for all places on the earth. The zenith is shown for any place and time. The altitude and azimuth for any celestial object at any place and time is readily obtainable by using dividers and a protractor. The duration of sunlight and darkness for any place and day is easily obtained by dividers. This information is often needed by aeroplane navigators.

The hour-ring supports both halves of the celestial sphere. A circle is drawn on the globe 90 degrees from the observer to represent the celestial horizon.

From a study of this planetarium it is apparent that from Winnipeg at 50° N. latitude the stars can be seen which are overhead for North America and South America as far south as the Argentine, all of Europe, Russia, the northern half of China and Japan. Winnipeg observers can actually see which stars are overhead at such points as London, Berlin, Leningrad, Helsinki, Tokyo or any other point within the line representing the celestial horizon. For instance, when an observer at Winnipeg sees a constellation rise which has a north declination of 32°, such as the heavenly twins, that constellation is directly overhead in Palestine.

At the present time the planetarium which is most famous consists of an electric lantern which projects the stars upon the inner surface of a large dome. It costs hundreds of thousands of dollars. The instrument briefly described here provides many of the benefits of the large one at slight expense.

109 Lanark St.,
Winnipeg, Man.

REQUEST FOR OBSERVATIONS OF THE TRANSIT OF MERCURY, NOVEMBER 11, 1940

CAPTAIN J. F. Hellweg, Superintendent of the United States Naval Observatory, Washington, D.C., has called to our attention the importance of good amateur observations of the transit of Mercury next November.

Due to the high inclination of the orbit of Mercury to the plane of the ecliptic, about seven degrees, the planet usually passes north or south of the sun at times of inferior conjunction. When such a conjunction occurs when Mercury is near one of its nodes, however, the planet transits the disc of the sun. The earth passes the nodes on May 7 and November 9, and hence it is only when inferior conjunctions occur near these dates that there can be transits of Mercury. Transits of Mercury, while much more common than those of Venus, are rather infrequent, there being about a dozen a century. Observations of transits are of scientific value in the determination of the planet's orbital elements, and in checking the irregularities of the earth's rotation.

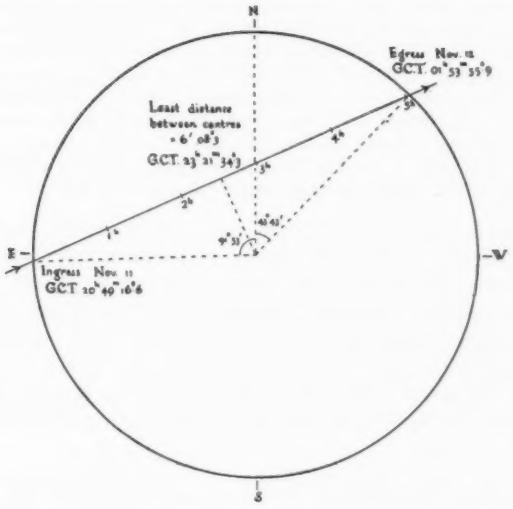
The accompanying information concerning the transit of November 11, 1940, is reprinted from the *Observer's Handbook* of the R.A.S.C.

Transit of Mercury, 1940 November 11-12

A transit of Mercury over the sun's disk, 1940 November 11-12, is partly visible in Canada. The ingress is visible generally in North America except the northeastern part, South America except the extreme eastern part, the Pacific Ocean, the Antarctic Ocean, Australia, and the extreme northeastern part of Asia. The egress is visible generally in the extreme northwestern part of North America, the Pacific Ocean except the extreme eastern part, Australia, Polynesia, the Antarctic Ocean, the Indian Ocean, and Asia except the extreme western part.

The accompanying table gives, for each Time Zone, the Standard Time of ingress for an observer on the standard meridian. In order to find the position of Mercury on the sun's disk at sunset, using the diagram below, the table gives the times between ingress and sunset for various latitudes.

Standard Time Zone	Standard Time of Ingress	Time between ingress and sunset, for standard meridian				
		36°	40°	44°	48°	52°
Eastern....	3 49 P.M.	$1^h\ 07^m$	$0^h\ 58^m$	$0^h\ 50^m$	$0^h\ 40^m$	$0^h\ 27^m$
Central....	2 49 P.M.	2 07	1 58	1 50	1 40	1 27
Mountain..	1 49 P.M.	3 07	2 58	2 50	2 40	2 27
Pacific.....	12 49 P.M.	4 07	3 58	3 50	3 40	3 27



The Geocentric Phases of the Transit of Mercury, 1940 November 11–12. The positions of Mercury on the sun's disk are shown at one-hour intervals from the time of ingress, external contact.

This transit will be more favourable than any previous one this century, and second only to that of 1973. We quote from Captain Hellweg's letter:

> It is therefore doubly important that the astronomers, both professional and amateur, who are so situated that they can observe this transit should be urged to make definite plans to observe and to allow nothing within their control to interfere with their observations. Of course, bad weather will prevent proper seeing.

Experienced observers are not necessary for this type of observation. It is only necessary that the observer knows what to look for. Any educated person can secure an observation of value if he has a telescope, a page of instructions "what to do", and knows his time accurately to within one or two seconds. Most of the uncertainty in observations is due to atmospheric conditions and this uncertainty can be reduced only by multiplying the number of observations.

There are several thousands amateur astronomers in this country who own telescopes. Most of them will be intensely interested in a phenomenon occurring so seldom as a transit of Mercury. It is only necessary to impress upon them that their observations will be of scientific value if they will all make observations carefully following instructions. The fact that only the ingress can be observed in the United States does not detract greatly from the value of their results.

All astronomers, both professional and amateur, who co-operate in observing this transit are request to transmit their results to the U.S. Naval Observatory, Washington, D.C., where reductions of all observations will be undertaken.

Instructions for all amateurs willing to co-operate in the observation of this transit, and for all those wishing further information, are now being mimeographed and will be forwarded to anyone requesting them.

Canadian observers will note that the ingress is visible over most of Canada. With our widely scattered membership, and a considerable number of telescopes, our Society should be in a position to make a definite contribution to this interesting and valuable observational project. Modern radio time signals should make it easy for careful observers to secure observations to a sufficient degree of accuracy. "The results of previous transits have always suffered from the too small number of observations obtained."

David Dunlap Observatory, F. S. H.
Richmond Hill, Ontario.

PLATE XI

W. E. Harper

WILLIAM EDMUND HARPER, 1878-1940

WILLIAM EDMUND HARPER, 1878-1940

By R. Meldrum Stewart

(with Plate XI)

THE death of Dr. Harper on June 14, 1940, brought to a close the career of one of the most eminent of Canadian astronomers, and of one who had had no small share not only in placing his native land on the astronomical map, but in the very material advancement of his particular branch of the science as a whole.

His professional career covers practically the whole period of astronomical research in Canada. On graduation in 1906 he joined the staff of the Dominion Observatory at Ottawa, which had been organized only the year before. For a number of years thereafter, as a member of the astrophysical division of the observatory, he formed one of a small group of workers who devoted themselves mainly to radial velocity work, and particularly to the determining of spectroscopic binary orbits. It was considerations founded upon the work of this group that emphasized the need for more powerful equipment—a need which was finally met by the establishment of the Dominion Astrophysical Observatory at Victoria.

It is of interest to note that it was Dr. Harper himself who originally recommended the selection of Victoria as the site of the projected institution, where he was later to serve, and of which he eventually became director. Originally there had been no thought of erecting the new large telescope elsewhere than at Ottawa. However, it was early recognized that the site of a telescope which was to be larger than any at that time in existence should be chosen with the greatest care, so that its performance should not be marred by any "seeing" short of the best available in the country. As soon as Government approval had been obtained for the project in 1913, Harper was entrusted with the task of testing observing conditions at a number of points scattered across Canada. The tests occupied several months, with the outcome that, while some other localities excelled in atmospheric transparency and freedom from cloudy skies, the vicinity of Victoria was easily first in steadiness of seeing, the most important factor of all. Consequently, after some confirmatory tests at a different season of the year, the final choice was Observatory

Hill, the present site of the observatory. That choice has been amply justified by subsequent experience.

Though the observatory was completed and work begun in 1918, it was not until a year later that Harper was transferred from Ottawa, where he had in the meantime been in charge of astrophysical work. At Victoria he served for 21 years in capacities of increasing responsibility, becoming assistant director in 1924 and director in 1936.

Born at Dobbinton, Bruce County, Ontario, on March 20, 1878, William Edmund Harper received his primary education in his native village, continuing at the high school in Owen Sound. After graduation from the high school, like so many others of the self-reliant young men of his day, he spent the next three years teaching school, to provide funds to finish his education. Entering the University of Toronto in the autumn of 1902, he was the first graduate in the newly established course of astronomy, and the first recipient of the gold medal of the Royal Astronomical Society of Canada. On the day of his graduation in 1906, the die was cast which definitely decided his professional astronomical career, for on that day he received a telegram informing him of his appointment to the staff of the Dominion Observatory. Three years later, on May 12, 1909, he was united in marriage to the sweetheart of his boyhood days, Maude Eugenia Hall, daughter of Samuel Hall of Marmion, Ontario. Their two daughters inherited their father's love of teaching, Evelyn being an accomplished musician and Louella a successful high school teacher.

As a man Dr. Harper was universally respected and admired by a wide circle of friends and acquaintances. What was perhaps his most distinguishing characteristic was an outstanding integrity and sincerity which could not fail to win respect even on casual contact, a feeling which speedily deepened into esteem on closer acquaintance. Add to this an entire absence of any spirit of self-seeking and a complete devotion to his chosen work, and we have a picture of the underlying motives of his career. One specific example may be permitted. It so happened that, on his appointment as director of the Victoria observatory, certain unavoidable adjustments involving superannuation rearrangements and other matters resulted in a slight temporary decrease in actual financial emolument. To a letter from

the writer, in which regret was expressed in this connection, he made the following characteristic reply—"After all, the main consideration is not my personal gain, but the success of the observatory. If the work does not suffer—and I trust it will not—then other things are secondary."

His professional life was devoted almost exclusively to the study by spectroscopic methods of the motions and distances of the stars. During his 13 years at Ottawa he published nearly 50 papers, the large majority of them dealing with observed radial velocities and the orbits of spectroscopic binaries deduced from the observations. Shortly after joining the Victoria staff he embarked, in collaboration with Young, on a study of spectroscopic parallaxes; after several years' intensive work this resulted in the publication in 1924 of a list of over 1100 parallaxes, mostly of later type stars, deduced by the spectroscopic method from Victoria plates. Later Harper alone extended the investigation to the more difficult field of Class A stars and derived a modified system of applicable criteria which he utilized in later years as opportunity offered. This has resulted in an accumulation of some seven hundred parallaxes of Class A stars, as yet unpublished. But his main work, at Victoria as at Ottawa, continued to be the observation and reduction of radial velocities and the derivation of orbits of binary stars. In this field his volume of output has not been even approached by any other astronomer; indeed, with over 100 orbits to his credit, he produced approximately one quarter of the total number known. In the measurement of radial velocities he was equally prolific. During his 21 years at Victoria he measured over 7000 plates. The total number of published articles to his credit is well over 200, though a considerable number of these were of a popular character.

Aside from his research problems, he did much to popularize the study of astronomy. Ever since his undergraduate days he was an enthusiastic member of the Royal Astronomical Society of Canada, and frequently served on the executives of both the Ottawa and Victoria Centres. During his two years as president of the national body, in 1928 and 1929, he sponsored a series of popular astronomical articles which appeared fortnightly for nearly the whole period in a syndicate of newspapers extending across Canada. The revenue accruing from these articles he devoted to a trust fund for the further-

ance of amateur astronomy under the auspices of the Society. For about twelve years he gave monthly radio talks on astronomical subjects over the Victoria broadcasting station, which greatly stimulated general astronomical interest throughout that whole region, and even much farther afield. Many of these talks have appeared from time to time in this JOURNAL, as well as numerous other articles, both popular and scientific, from his pen. More ephemeral, though perhaps just as effective in stimulating interest, were the many popular lectures which he delivered from time to time to the various Centres of the Astronomical Society, as well as to service clubs, church organizations, and many other bodies in different parts of the country.

His social activities, aside from those directly arising from his vocation, were largely centred around the church. For twenty years he was a member of the official board of the Metropolitan Church at Victoria, and several times its chairman. He did a great deal to foster the interest of young people in the church and its social life, and gave generously of his time and substance toward the same ends.

He was a thorough believer in the efficacy of athletics as a recreation. All his life he took a keen interest in friendly games of skill; in his youth he was a keen soccer player and in later years an ardent and skilful devotee of tennis, badminton and golf.

Recognition of his abilities and his services to astronomy came to him in various ways. In 1907, a year after his graduation, he received the degree of M.A. from the University of Toronto; in 1913 he became a Fellow of the Royal Astronomical Society of Canada, of which he had already been a member for some years, and of which he was later president; in 1924, the year of his appointment as assistant director of his observatory, he received the further honour of election as a Fellow of the Royal Society of Canada, the leading and most exclusive learned Society of his native land. On the occasion of the dedication of the David Dunlap Observatory of the University of Toronto in 1935, the honorary degree of Doctor of Science was conferred on him by his Alma Mater in recognition of his meritorious services to astronomy. The final honour conferred on him, only a few weeks before his death, was his election as vice-president of the Section of Mathematical and Physical Sciences of the Royal Society of Canada. He was a Fellow of the American Association for the Advancement of Science and a member of the

American Astronomical Society; in the International Astronomical Union he was a member of the Commission on Radial Velocities and the Commission on Parallaxes, as well as being a member *ex officio* of the Canadian National Committee.

One of his last official duties, before his final illness, was to serve as official Canadian delegate to the General Assembly of the International Astronomical Union at Stockholm in August, 1938. Though not in the best of health at the time, he spent several strenuous months in preparation, in attendance at the meeting of the A.A.A.S. at Ottawa, where he presented a number of papers, and in profiting by the opportunity to visit various observatories in Britain. Immediately following the Stockholm meeting, while on his way to Germany to undertake a further tour of European observatories, exhausted nature took its toll, and he was suddenly stricken with pneumonia. He was taken from the train to Rostock hospital, where for several weeks he lay critically ill. The situation was far from improved by the international crisis which developed at that time, and which finally necessitated his removal by ambulance to Denmark, and thence by boat to England. After his return to Canada in October his health improved somewhat, and at the close of the year he doggedly resumed his duties at the office and attempted to carry on. But his health had been too seriously undermined, and in the spring he suffered a serious relapse, which a year later proved fatal.

To his staff at the observatory, as well as to his colleagues elsewhere, and to a host of other friends, he had endeared himself not less by his high attainments and his positive qualities than by his modest unassuming character and his personal worth. We have lost a valued friend, a worthy Canadian, and a distinguished man of science.

Dominion Observatory,
Ottawa, Ontario.

FINE GRAIN DEVELOPERS FOR SCIENTIFIC PHOTOGRAPHY

By William H. Wood

(with Plate XII)

FOR many photographic applications in scientific work, a fine grain developer for negative emulsions has particular utility. Most of such applications will be those where maximum detail must be obtained in images of very small size, with as complete as possible retention of the resolving power of the emulsion used. Applications such as spectrum analysis in astronomy and physics, photomicrography in the biological sciences and in metallurgy, aerial photography for maximum detail of the terrain, and scientific photography in criminal investigation work are suitable illustrations of uses for fine grain developers.

Fine grain developers may be classified under two main types: chemical developers and physical developers. There is no absolute dividing line differentiating these two types, since development by the physical process is really a chemical process. However, with the fine grain chemical developer, most of the silver in the developed image of the negative is silver which has been formed in situ by a chemical reduction of the silver halides containing the latent image, whereas with physical developers, much of the silver in the developed image has been plated out on the developing latent image by the reduction of a complex silver salt contained in the developer itself.

Practically all of the moderately fine grain chemical developers contain paraphenylene diamine as the active developing agent.[1] Such developers do give fine grain images, but the loss of emulsion speed for many applications is very serious, and the negatives are thin and lacking in contrast. More active chemical developers of the metol-borax type do not give images of sufficiently fine grain to be usable for many of the mentioned applications. The addition of silver halide solvents improves developers of the metol-alkali borate type.[2] Such solvents may be thiocyanic acid salts. Developers of this class are

[1] *The British Journal Photographic Almanac*, 1940; p. 225.

[2] *The British Journal Photographic Almanac*, 1940; p. 226. Also *Photographic Chemicals and Solutions*, Crabtree and Matthews, p. 337.

somewhat inferior to metol-borax developers in activity, but the resulting grain structure of developed images is better.

Developers of the physical type, or those plating out silver on the developing image, are generally capable of developing negative images of minimum graininess. All published formulas for such solutions, however, while giving developers usable under certain conditions, are by no means suitable for a wide range of work. Previously known physical developers[3] are difficult to use, deteriorate rapidly, result in a very serious loss of emulsion speed, and require quite extended development times. Perhaps the best known physical developer formula published during the past few years is the one worked out by the late Dr. Allan Odell, of the E. I. DuPont de Nemours Company.[4]

These physical developer formulas, while giving finer grain images than straight chemical developers, are frequently erratic and unreliable in action.

Physical developers compounded so as to include a weak silver halide solvent which forms complex, easily dissociated silver salts have none of the disadvantages of other physical developers. At the same time, they have many qualities superior to ordinary physical developers. For example, they are stable in solution even after use; they deteriorate very slowly; silver replenishment comes from each fresh emulsion placed in the developer; emulsion speeds are only slightly inferior to those resulting from the use of active chemical developers, and the developed image is even finer grained than that produced by previously known physical developers.

Suitable weak silver halide solvents are the sulphites of certain cyclic organic amines, such as morpholine. Morpholine sulphites added to a developer of the glycin or paraphenylene diamine type, in the presence of an alkaline metabisulphite or an alkanolamine such as ethanolamine, produces a very good physical developer with excellent fine grain characteristics. Not only is the physical development action pronounced, but the silver halide solvent functions to reduce still further the grain size. In this respect, the amine sulphite is somewhat comparable to the thiocyanates in its action. Further, the morpholine

[3] *The Photographic Process*, by J. E. Mack and M. J. Martin; p. 514.
[4] *The British Journal Photographic Almanac*, 1940; p. 227.

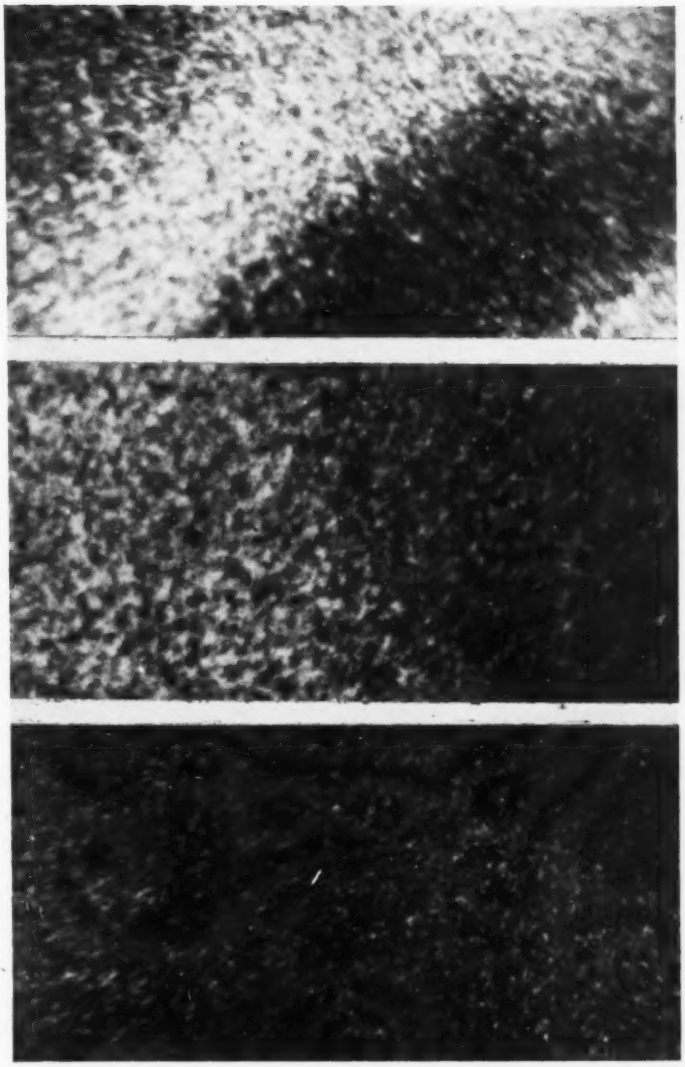
sulphites are good anti-foggants, and this property is of considerable value in developing high speed emulsions.

Physical developers containing morpholine sulphites enable users to employ the highest speed emulsions and still obtain images with less graininess than those obtained by the use of a lower speed emulsion developed in an active chemical developer. A physical developer of the morpholine sulphites type is marketed under the trade name Refract-O-Grain.

Plate XII shows a comparison of the graininess produced by development with the three types of developer.

Research Laboratory,
Harris Seybold Potter Co.
Cleveland, Ohio
March 25, 1940

PLATE XII



Enlargement, 500×, of Panatomic X film, showing graininess as developed in
Thiocyanate type developer (above).
Odell physical developer (centre).
Morpholine type physical developer—Refract-O-Grain (below).

Journal of the Royal Astronomical Society of Canada, 1940.

STAR IDENTIFICATION AIDS

By James Weir

THE navigator, if concerned with practical astronomy, must identify an observed star before it is of service. This held before catalogues and star maps were devised; and their addition has aided in, but cannot supersede, the necessity of the memory for configurations and order in the stellar processions.

> Si modo rite memor servata remetior astra—*Aen.* v. 35.
> If only recalling duly, I follow back the stars observed.

This motto summarizes the art of Palinurus.

The skeleton of right ascension and declination circles imposed on a fictitious celestial sphere—just as longitude and latitude circles on a real earth—furnishes now the control necessary for the 'increased almanach.' The recognition of the spacing of these circles among the stars is the first aid in acquiring a system of stellar memory. We commence with right ascension (R.A.) which gives, in the diurnal circular processions of stars, the order of time in which they pass over the meridian of any observer.

It may be recalled that the ancients concerned themselves with the Signs of the Zodiac in their relations to the recurring seasons. To memorize their order is at once a great aid. Their Latin names are given:

> Sunt: Aries, Taurus, Gemini, Cancer, Leo, Virgo,
> Libraque, Scorpius, Acitenens, Caper, Amphora, Pisces.
>
> They are the Ram, the Bull, The Twins, Crab, Lion, Virgin,
> and The Balance, Scorpion, Archer, Goat, Water Jar, Fishes.

Identification by Right Ascension

It is of the greatest advantage to fix in mind the R.A. of certain bright stars for field reference. Each practical observer will have done so. Memory requires association, contrast, repetition and mnemonic aids. One must not confuse another's system by imposing his own. With apology for deserting the dignity of Latin quotation for original doggerel, some illustrations of a system which, in one case, did "stick", are given. The times mentioned are under-

stood to be local sidereal. This corresponds to the R.A. of any star at its upper transit of the local meridian.

Alpha Androm. and Beta Cass.
At zero hours six minutes pass.

These pointers (30° apart) check the timepiece for events.

Gamma Androm. at two hours flat,
Almach is special name for that.

Taurus, the Bull, his neck, at four
The Right Ascension line doth score.

The neck at four may be indefinite. Aldebaran, the Bull's Eye, at 4^h33^m, is not. The time is one hour ahead of that of Alnilam, the middle star of the three in Orion's Belt.

Orion's belt at half-past five,
Slung 'neath the equator, doth arrive.

Rigel and Capella have passed at 5^h12^m.

Five fifty-two brings Betelgeux,
In fifty more its Sirius.

Castor ascends at half-past seven,
To which for Pollux add eleven.

Procyon—the name is Greek—
Up to the heavenly twins doth peek.

Alpha Hydrae, called Alphard,
Nine twenty-five is on its card.

Alphard is isolated from other bright stars.

From Leo's ear ten hours adduce;
The sickle hand holds Regulus.

α and β Ursae Majoris are better known as the Pointers in the Dipper. Alpha crosses "at the eleventh hour", Beta two minutes sooner.

Eleven forty-six—all hail!
Denebola in Leo's tail.

One now passes twelve hours.

Mizar (ζUMaj) and Spica Virginis (66°05′ apart) cross at 13^h22^m.

Arcturus, located 30°38′ from the tip of the Bear's tail, and 32°50′ from Spica, crosses at 14^h13^m. It is a mystery how the time is remembered. For angular distances, the knuckles of the extended hand cover about 8°.

Alpha and Beta of the Balance recall the twins, Castor and Pollux, but are twice as far apart as are the Twins. α Librae is 13^m before fifteen hours, and β Librae 13^m after. β Librae is thus one hour after Arcturus.

Alphecca (α Coronae Borealis) and Rasalague (α Ophiuchi) at $15^h32^m09^s$, and at $17^h32^m09^s$, respectively, are precisely 2^h apart. A mean time watch loses twenty seconds in this interval.

> Antares doth the Scorpion fix,
> At sixteen hours twenty-six.

Vega, at 18^h35^m; Altair, at 19^h48^m; and Deneb, at 20^h39^m, provide a grand triangle, the area of which is 2 per cent. of a hemisphere.

Possibly one remembers the R.A. of Vega in the Lyre, from the year 1835. Of that vintage "hardly a man is now alive." For Altair, in the Eagle, the R.A., 19^h48^m is associated with the year 1948, a prospective date of good omen.

α Aquarii, just below the equator, and in line with the α Andromedae, α Pegasi (20°12′) diagonal of the Square of Pegasus itself extended 21°18′, is in R.A. 22^h03^m, or a few minutes after 22^h.

β Pegasi (R.A. 23^h01^m) and α Pegasi (R.A. 23^h02^m), 12°53′ apart, provide the pointers in the Square of Pegasus which, being nearly 12^h greater in R.A. than the Pointers of the Dipper, point to the N. Pole in the opposite sense.

> Comes Scheat, Beta Pegasi,
> A minute after twenty-three;
> One minute more, and then to flee
> With Markab, Alpha Pegasi.

Local Sidereal Time

As remarked, the R.A. of a star at upper transit over the meridian of a place gives there the local sidereal time. A useful procedure for estimating, without an almanac, and at any time, what

stars are crossing will be outlined. With some practice, the process may be completed blindfolded. The required data are, longitude expressed in time (15° = 1 hour), the date, and the time expressed in Greenwich Civil Time.

The sum of all days from the preceding March 21.5, if in a leap year—otherwise, from March 22.5—up to and including the chosen date, is multiplied by four minutes. The product, in hours and minutes, is reduced by one minute for every hour in its content. This gives the Greenwich Sidereal Time at Greenwich Mean Noon of the date,—G.S.T. at G.M.N.

Take the interval between the given G. Civil Time and G. Mean Noon (12 hours) and increase it by ten seconds per hour. The corrected interval, combined with the G. Sid. T. at G.M.N., gives the actual G. Sidereal Time.

As a difference of longitude equals a difference of time, the combination of the longitude and the G. Sidereal Time gives the Local Sidereal Time.

Example: Jan. 1, 1941, at 4^h30^m G.C.T., in Long. 15°30′E., find the local sidereal time.

Solution: 15°30′E. = 1^h02^m E. Long.

Days from Mar. 21.5, 1940, to Dec. 32 incl. = 285.5.

285.5 × 4 min. = 1142 m. = 19^h02^m.

Reducing this by 19 m., the G.S.T. at G.M.N. Jan. 1, 1941 = 18^h43^m.

4^h30^m G.C.T. = 7^h30^m before G.M.N. This interval, increased by 70°, gives an interval of 7^h31^m.

Hence G.S.T. = $18^h43^m - 7^h31^m = 11^h12^m$.

As the Long. is 1^h02^m E., the Local Sidereal Time is 12^h14^m.

The star δUMaj, at the junction of the handle and the Great Dipper, and γ Corv (in the "Cutter's Main Sail") have just culminated at the time and longitude given.

It is a convenience to recall some stars near upper culmination at nine hours P.M., of civil time, at various seasons:

Jan. 1st.—The Pleiades
Feb. " Betelgeux (αOrio)
Mar. " Castor and Pollux (Twins)
Apr. " The Sickle (Leo's head)
May " Denebola (Leo's tail)

June " ηUMaj (tip of Dipper handle)
July " αCorB (Northern Crown)
Aug. " βOphi (in Serpent-bearer)
Sept. " Altair (αAqil)
Oct. " ϵPegs (nose of Pegasus)
Nov. " The Square of Pegasus
Dec. " Polaris

Declinations. Second Aid in Star Identification

Declinations of stars are best understood from their analogy to terrestrial latitudes.

The N. Pole of the celestial sphere may be pointed out readily. The star Polaris, whose declination is +88° 59′ (1940.0) is thus 1° 01′ from the Pole. This small angle is 4 per cent. less than twice the angular diameter of the sun. The width of a finger, when the hand is extended twenty-one inches from the eye, will subtend this small angle. From ηUMaj (Alkaid) to αUMin (Polaris) the line runs across the N. Pole. These stars are at the respective handle tips of the Great Dipper and Little Dipper. One had but to clip off 1°01′ from the Polaris end of the 40°23′ arc joining the handle tips to be right on the N. Pole. Point here and your pointer is parallel to the axis of the earth.

To sweep out the plane of the equator with the arms is good exercise. Point the left arm to Polaris and the right arm to the east point of the horizon. The arms thus are at 90°. Hold this inclination, and sweep out part of the equator by swing of the right arm. Point the right arm to Polaris, and swing the left arm from the west point.

The sun at the equinoxes marks the equator. Should the sun's declination at another date be (say) +8°, extend the arm so that the fist, held from the sun southward (in the direction opposite to the pole) will subtend 8°. The upper star δ in Orion's Belt (Dec. −0°20′), or the star αAqar (Dec. −0°37′), are good marks to remember. Aldebaran (Dec. +16°23′) and Sirius (Dec. −16°38′) are about two fists' width, respectively, above and below the equator. The spread from thumb to little finger tips corresponds to the +19°30′ declination of Arcturus.

The star Deneb (+45°04′) is practically midway from equator to pole; Capella (+45° 56′) somewhat more.

Declination +60° passes between the Pointers of the Dipper.
Declination +30° passes between Castor and Pollux.
Declination −30° passes just below Fomalhaut (−29° 56′).
Declination −60° passes above Alpha Centauri (−60° 35′).

One need not memorize many declinations. By emulating Pollux, who was said to have been good with his fists, one may always make fair estimates of declinations for purposes of star identification.

Declinations correspond to terrestrial latitudes. From this, it is an interesting exercise in geography to trace out substellar places. From some of these place names, and the expectation of the star which is to cross directly overhead, worthwhile ideas, both as to latitudes and declinations, are to be gained. The following table will illustrate. The G. Sidereal Times are given, in case interpolations for other longitudes are considered:

SOME SUBSTELLAR PLACES

Star	Declination	Place	G.S.T
			h m
β Cass (Caph)	+58°49′	Scapa Flow, in Orkneys	0 18
		Ft. Churchill, Hudson Bay	6 23
β Ceti (Deneb-Kaitos)	−18 19	C. Frio, W. Africa	0 00
		N. of Arica, Chile	5 22
γ Cass	+60 24	Bergen, Norway	0 32
		Bering Sea	12 00
β Andr (Mirach)	+35 18	Mediterranean Sea	0 00
		Yokohama, Japan	15 48
γ Andr (Almach)	+42 03	Black Sea	0 00
		Rome, Italy	1 10
α Arie (Hamal)	+23 11	Assuan, Egypt	0 00
		Habana, Cuba	7 33
β Pers. (Algol)	+40 44	Caucasus, Russia	0 00
		New York City, U.S.A.	8 00
Pleiades	+23 55	G. of Persia, Oman	0 00
		Central Formosa	19 40
α Taur (Aldebaran)	+16 23	Arabian Sea	0 00
		Port Louis, Guadeloupe, W.I.	8 39
β Orio (Rigel)	− 8 16	Bali Island, Pac. Ocean	21 30
α Auri (Capella)	+45 56	L. Balkash, Asia	0 00
		Louisbourg, N.S.	9 12
δ Orio (Mintaka)	− 0 20	C. Pasada, Ecuador	10 51
α CMaj (Sirius)	−16 38	Mt. Dana, Fiji	18 47

α Gemi (Castor)	+32 01	Hankow, China	0 00
		Savannah, Ga.	12 55
α UMaj (Dubhe)	+62 04	Strom Is., in Faeroes Is.	11 27
ζ UMaj (Mizar)	+55 14	Inishowen Head, N. Ire	13 49
η UMaj (Alkaid)	+49 37	Cherbourg, Fr.	13 52
α Scor (Antares)	−26 18	Johannesburg, S. Afr.	14 34
γ Drac (Etamin)	+51 30	London, Eng.	17 55
α Lyra (Vega)	+38 44	Lisbon, Portugal	19 12
α Cygn (Deneb)	+45 04	Turin, Italy	20 09
α PscA (Fomalhaut)	−29 56	Coquimba, Chile	3 40

Star	Declination	Place	G.S.T. h m

Angular Distances between Stars

To the navigator, the identification of a star in a broken sky may be of vital importance. The following table of angular distances, computed from the mean places of 1940, may prove useful. With the correct angle set on a sextant, it is a simple matter to bring together two stars. However, as in this table more than a score of triangles approximately isosceles may be found, a positive identification may require the use of two angles. Without a sextant, a calibrated envelope, or the hand, may serve the purpose of estimating angles. As the combinations are infinite, the obvious angles of the brighter navigational stars have been selected somewhat exclusively. Following the table, some alignments and figures of stars are given. As their angular distances may be found in the tables, these are not repeated.

Angular Distances between Stars

The name of a star, its R.A. and Dec. for 1940.0 and its magnitude are given in one line. Then follow the distances in degrees and minutes from this star to the several stars named.

Example: the distance from αAndr to βAndr is 14° 29′; to γAndr, 26° 44′; and so on.

I. *Northern Stars*

α Andr (Alpheratz), R.A. $0^h5.3^m$, Dec. +28°46′, mag. 2.2
Distances: βAndr 14 29, γAndr 26 44, βCass 30 04, βPegs 14 13, αPegs 20 12, γPegs 13 57, αArie 27 08, αAuri 60 57, αCass 28 02

β Cass (Caph), R.A. 0^h 6.0^m, Dec.+58° 49′, mag. 2.4
Distances: αCass 4 55, γCass 6 09, αAndr 30 04, αUMin 30 15, αUMaj 58 16

γ Pegs (Algenib), R.A. 0^h 10.2^m, Dec.+14°51′, mag. 2.9
Distances: βAndr 24 02, αAndr 13 57, βPegs 20 37, αPegs 16 31, βCeti 34 00, αCeti 43 01, αArie 28 02, βArie 24 44

α Cass (Schedir), R.A. $0^h$$37.1^m$, Dec.+56°12′, mag. 2.4
Distances: βCass 4 55, αAndr 28 02, γCass 4 41, αUMin 32 49

β Ceti (Deneb-Kaitos), R.A. $0^h$$40.6^m$, Dec.−18°19′, mag. 2.2
Distances: βOrio 66 23, αCeti 40 42, αArie 46 12, γPegs 34 00, αPscA 26 47

γ Cass R.A. $0^h$$53.1^m$, Dec.+60°24′, mag. 2.2
Distances: βCass 6 09, αCass 4 41, δCass 3 37, αUMin 28 37, αPers 23 14

β Andr (Mirach), R.A. $1^h$$06.4^m$, Dec.+35°18′, mag. 2.4
Distances: αArie 17 24, βArie 17 24, γAndr 12 28, αAndr 14 29, γPegs 24 02

δ Cass (Ruchbah), R.A. $1^h$$21.9^m$, Dec.+59°55′, mag. 2.8
Distances: γCass 3 37, εCass 4 48, αUMin 29 04

α UMin (Polaris), R.A. $1^h$$42.6^m$, Dec.+88°59′, mag. 2.1
Distances: αAndr 60 19, βCass 30 15, αCass 32 49, γCass 28 37, βAndr 53 41, δCass 29 04, γAndr 45 56, βPers 48 19, αPers 39 25, αTaur 72 51, αAuri 43 27, αOrio 82 08, αGemi 57 56, βGemi 61 50, αLeon 78 20, αUMaj 28 42, βLeon 75 59, ζUMaj 35 47, αBoot 71 31, βUMin 16 35, γDrac 38 58, αLyra 51 35, αAqil 81 16, αCygn 44 12, αCeph 27 16, βPegs 61 28, εUMaj 34 43, ηUMaj 41 25, βHerc 69 09, αCorB 64 00

γ Andr (Almach), R.A. 2^h 00.2^m, Dec.+42°03′, mag. 2.3
Distances: αArie 18 53, αTaur 41 25, βPers 12 04, αPers 15 47, αAuri 34 14, αAndr 26 44, βAndr 12 28

α Arie (Hamal), R.A. 2^h 03.8^m, Dec.+23°11′, mag. 2.2
Distances: βCeti 46 12, αCeti 23 30, αTaur 35 32, ηTaur 22 56, αAuri 44 07, βArie 3 56, γAndr 18 53, βAndr 17 24, αAndr 27 08, γPegs 28 02

α Ceti (Menkar), R.A. $2^h$$59.2^m$, Dec.+3°51′, mag. 2.8
Distances: βCeti 40 42, βOrio 35 12, αTaur 26 07, ηTaur 22 47, αArie 23 30, γPegs 43 01

β Pers (Algol), R.A. $3^h$$04.3^m$, Dec.=40°44′, mags. 2.3, 3.5
Distances: αPers 9 21, γAndr 12 04, αAuri 23 41

α Pers (Marfak), R.A. $3^h$$20.0^m$, Dec.+49°39′, mag. 1.2
Distances: βPers 9 21, γAndr 15 47, αAuri 19 06, γPers 4 44, δPers 3 42, γCass 23 14

η Taur (Alcyone), R.A. 3^h 43.9^m, Dec.+23°55′, mag. 3.0
Distances: αTaur 13 39, αAuri 28 18, αArie 22 56, αCeti 22 47

α Taur (Aldebaran), R.A. $4^h$$32.5^m$, Dec.+16°23′, mag. 1.1
Distances: βOrio 26 30, αCMaj 46 01, αOrio 21 23, βTaur 16 45, αAuri 30 42, ηTaur 13 39, γAndr 41 25, αArie 35 32, αCeti 26 07, δTaur 3 16

β Orio (Rigel), R.A. $5^h$$11.7^m$, Dec.−8°16′, mag. 0.3
Distances: αArie 55 39, αOrio 18 36, εOrio 8 50, γOrio 14 46, κOrio 8 20, αTaur 26 30, αCeti 35 12, βCeti 66 23, αLeps 10 35, αCMaj 23 40, αCMin 38 32

α Auri (Capella), R.A. $5^h12.3^m$, Dec.+45°56′, mag. 0.2
Distances: γAndr 34 14, αAndr 60 57, αArie 44 07, ηTaur 28 18, αTaur 30 42, βOrio 54 12, βTaur 17 30, ηTaur 28 18, αOrio 39 29, αCMaj 65 49, γGemi 34 05, αCMin 51 07, βGemi 34 15, αGemi 29 59, αLeon 69 36, βAuri 7 35, αLyra 93 20, αBoot 103 10, αCygn 78 11, βPers 23 41

δ Orio (Mintaka), R.A. $5^h28.9^m$, Dec.−0°20′, mag. 2.5

ϵ Orio (Alnilam), R.A. $5^h33.2^m$, Dec.−1°14′, mag. 1.8

ζ Orio (Alnitak), R.A. $5^h37.7^m$, Dec.−1°58′, mag. 2.0
Distances: δϵ1 23 14, ϵζ1 21 21, δζ2 44 15, ϵβ8 50, ϵαOrio 9 49, γκOrio 16 59, ζθOrio 4 17

α Orio (Betelgeux), R.A. $5^h51.9^m$, Dec.+7°24′, mag. 0.5 to 1.1
Distances: γOrio 7 43, ϵOrio 9 49, βOrio 18 36, κOrio 17 06, αCMaj 27 05, αCMin 25 58, βGemi 33 12, αGemi 33 41, γGemi 13 45, αAuri 39 29, βTaur 22 16, αTaur 21 23

α CMaj (Sirius), R.A. $6^h42.5^m$, Dec.−16°38′, mag. −1.6
Distances: αOrio 27 05, αTaur 46 01, βOrio 23 40, αLeps 17 20, βCMaj 5 31, ϵCMaj 12 39, αCMin 25 42, αAuri 65 49, αTaur 46 01, αHyda 40 20, αCari 36 14

α Gemi (Castor), R.A. $7^h30.8^m$, Dec.+32°01′, mag. 1.6
Distances: αOrio 33 41, αAuri 29 59, γGemi 20 10, αCMin 26 40, βGemi 4 31, αLeon 40 32, αUMaj 44 40

α CMin (Procyon), R.A. $7^h36.2^m$, Dec.+5°23′, mag. 0.5
Distances: αOrio 25 58, βOrio 38 32, αCMaj 25 42, βCMin 4 18, αHyda 30 21, βGemi 22 50, αGemi 26 40, αAuri 51 07, γGemi 18 47, αLeon 37 25

β Gemi (Pollux), R.A. 7^h 41.7^m, Dec.+28°10′, mag. 1.2
Distances: αGemi 4 31, αAuri 34 15, αOrio 33 12, αCMin 22 50, αLeon 37 02

α Hyda (Alphard), R.A. $9^h24.6^m$, Dec.−8°24′, mag. 2.2
Distances: αLeon 22 59, αCMin 30 21, αCMaj 40 20, γCorv 41 49, αVirg 58 29, βLeon 42 05

α Leon (Regulus), R.A. $10^h05.2^m$, Dec.+12°16′, mag. 1.3
Distances: αAuri 69 36, αGemi 40 32, βGemi 37 02, αCMin 37 25, αHyda 22 59, αVirg 54 03, βLeon 24 38, δLeon 17 56, γLeon 8 21, αBoot 59 43, αUMaj 50 47

α UMaj (Dubhe), R.A. $11^h0.0^m$, Dec.+62°05′, mag. 2.0
Distances: βUMaj 5 22, δUMaj 10 13, ϵUMaj 14 02, ηUMaj 25 42, ζUMaj 19 20, αAuri 49 18, αGemi 44 40, αLeon 50 47, βCass 58 16, βUMin 23 19, αCVen 29 06

β Leon (Denebola), R.A. $11^h46.0^m$, Dec.+14°54′, mag. 2.2
Distances: αLeon 24 38, αHyda 42 05, αVirg 35 04, αSerp 58 14, αBoot 35 19, δLeon 10 15, γLeon 21 55

γ Corv (Gienah), R.A. $12^h12.7^m$, Dec.−17°12′, mag. 2.8
Distances: αVirg 17 58, γVirg 17 18, αHyda 41 49, βCorv 7 17

ϵ UMaj (Alioth), R.A. $12^h51.4^m$, Dec.+56°17′, mag. 1.7
Distances: αUMaj 14 02, αCVen 17 39, αUMin 34 43, ζUMaj 4 22

ζ UMaj (Mizar), R.A. $13^h21.5^m$, Dec.+55°14′, mag. 2.4
Distances: αUMaj 19 20, εUMaj 4 22, αVirg 66 05, ηUMaj 6 41, βUMin 21 05, αDrac 10 43

α Virg (Spica), R.A. $13^h22.0^m$, Dec.−10°51′, mag. 1.2
Distances: ζUMaj 66 05, βLeon 35 04, γVirg 14 31, αLeon 54 03, αHyda 58 29, γCorv 17 58, βCorv 17 12, αScor 45 54, αLibr 21 22, βLibr 27 33, αSerp 38 49, αBoot 32 50

η UMaj (Alkaid), R.A. $13^h45.2^m$, Dec.+49°37′, mag. 1.9
Distances: αUMaj 25 42, αCVen 14 21, βUMin 25 45, αBoot 30 38, αUMin 41 25

α Boot (Arcturus), R.A. 14^h 12.9^m, Dec.+19°30′, mag. 0.2
Distances: ηUMaj 30 38, αCVen 25 46, βLeon 35 19, αLeon 59 43, ηBoot 5 03, αVirg 32 50, αSerp 25 02, βHerc 31 33, αCorB 19 38, αLyra 59 05, αScor 56 00, αAuri 103 01

β UMin (Kochab), R.A. $14^h50.9^m$, Dec.+74°24′, mag. 2.2
Distances: γUMin 3 11, αUMin 16 35, ζUMaj 21 05, ηUMaj 25 45, α UMaj 23 19

α CorB (Alphecca), R.A. $15^h32.2^m$, Dec.+26°55′, mag. 2.3
Distances: βCorB 2 50, αBoot 19 38, αSerp 20 25, αOphi 31 32, βHerc 13 42, αLyra 39 43

α Serp (Unuk), R.A. $15^h41.3^m$, Dec.+6°37′, mag. 2.7
Distances: αBoot 25 02, αVirg 38 49, αScor 34 39, αOphi 27 56, βHerc 18 43, αCorB 20 25, βLeon 58 14

α Scor (Antares), R.A. $16^h25.7^m$, Dec.−26°18′, mag. 1.2
Distances: βScor 8 37, δScor 7 38, πScor 6 51, σScor 2 02, τScor 2 17, αAqil 60 15, ηOphi 14 20, αOphi 42 07, βHerc 47 55, αSerp 34 39, αLibr 25 08, αBoot 56 00, αVirg 45 54, αCent 39 05, σSgtr 32 33

α Ophi (Rasalague), R.A. $17^h32.2^m$, Dec.+12°36′, mag. 2.1
Distances: βOphi 8 16, ηOphi 28 56, ζOphi 27 14, αScor 42 07, αAqil 35 28, αLyra 29 36, βHerc 17 50, αCorB 31 32, αSerp 27 56

γ Drac (Etamin), R.A. $17^h55.2^m$, Dec.+51°30′, mag. 2.4
Distances: βDrac 4 07, αLyra 14 32, αCygn 27 40, αUMin 38 58

α Lyrae (Vega), R.A. $18^h34.9^m$, Dec.+38°44′, mag. 0.1
Distances: αCygn 23 51, γDrac 14 32, αCorB 39 43, αBoot 59 05, βHerc 32 08, αOphi 29 36, αAuri 93 20, αAqil 33 19

α Aqil (Altair), R.A. $19^h47.9^m$, Dec.+8°43′, mag. 0.9
Distances: γAqil 2 04, αLyra 33 19, αOphi 35 28, αScor 60 15, σSgtr 37 39, βAqil 2 42, αPscA 59 09, αPegs 47 36, εPegs 27 59, βPegs 49 14, αCygn 38 01

α Cygn (Deneb), R.A. $20^h39.4^m$, Dec.+45° 04′, mag. 1.3
Distances: αLyra 23 51, γCygn 6 08, αAqil 38 01, εPegs 37 53, εCygn 11 21, αAuri 78 11, αPegs 42 32, βPegs 32 56, αCeph 18 07, γDrac 27 40, β Cygn 22 17

ε Pegs (Enif), R.A. $21^h41.2^m$, Dec.+9°36′, mag. 2.5
Distances: αAqil 27 59, αPegs 20 22, βPegs 26 06, αCygn 37 53

α PscA (Fomalhaut), R.A. $22^h54.3^m$, Dec. −29°56′, mag. 1.3
Distances: βCeti 26 47, αPegs 44 51, βPegs 57 43, αAqil 59 09, σSgtr 52 58
β Pegs (Scheat), R.A. $23^h0.9^m$, Dec. +27°45′, mag. 2.6
Distances: αPegs 12 53, γPegs 20 37, αAndr 14 13, εPegs 26 06, αCeph 38 51, αCygn 32 56, αAqil 49 14, αPscA 57 43
α Pegs (Markab), R.A. $23^h01.8^m$, Dec. +14°53′, mag. 2.6
Distances: γPegs 16 31, αAndr 20 12, βPegs 12 53, αCygn 42 32, αAqil 47 46, εPegs 20 22, αPscA 44 51

II. Southern Stars

α Phoe, R.A. $0^h23.3^m$, Dec. −42°38′, mag. 2.4
Distances: βCeti 24 39, αErid 18 48, αPscA 21 55, αGrus 24 40
β Ceti (Deneb-Kaitos), R.A. $0^h40.6^m$, Dec. −18°19′, mag. 2.2
Distances: αPscA 26 47, αPhoe 24 39, αErid 40 32
α Erid (Achernar), R.A. $1^h35.5^m$, Dec. −57°32′, mag. 0.6
Distances: βCeti 40 32, αPhoe 18 48, αPscA 39 07, αGrus 32 51, αPavo 40 07, αCari 39 25
α Cari (Canopus), R.A. $6^h22.6^m$, Dec. −52°40′, mag. −0.9
Distances: αCMaj 36 14, αErid 39 25, βCari 25 39, αCrus 45 04
α Cruc (Acrux), R.A. 12^h 23.2^m, Dec. −62°46′, mag. 1.6
Distances: βCruc 4 14, γCruc 6 01, δCruc 4 34, αCent 15 40, βCent 11 52, αScor 53 28, αVirg 52 59, αCari 45 04, βCari 19 49
α Cent (Rigil Kentaurus), R.A. $14^h35.5^m$, Dec. −60°35′, mag. 0.3
Distances: βCent 4 28, αCruc 15 40, βCari 32 29, αTrAu 15 38, αPavo 41 40, εSgtr 44 07, αScor 39 05
α Scor (Antares), R.A. $16^h25.7^m$, Dec. −26°18′, mag. 1.2
Distances: αCent 39 05, εSgtr 25 53, σSgtr 32 33, αVirg 45 54, αCruc 53 28
ε Sgtr (Kaus Australis), R.A. $18^h20.2^m$, Dec. −34°25′, mag. 2.0
Distances: αCent 44 07, αTrAu 37 07, αPavo 30 22, αGrus 43 19, αPscA 57 04, σSgtr 10 30, αScor 25 53
α Grus (Al Na'ir), R.A. $22^h04.5^m$, Dec. −47°15′, mag. 2.2
Distances: αPscA 19 49, εSgtr 43 19, αErid 32 51, αPhoe 24 50, βGrus 5 49
α PscA (Fomalhaut), R.A. $22^h54.3^m$, Dec. −29°56′, mag. 1.3
Distances: βCeti 26 47, σSgtr 52 58, εSgtr 57 04, αPavo 37 54, αGrus 19 49, βGrus 17 30, αPhoe 21 55, αErid 39 07

Some Alignments

For the study of these, one should supply their angular distances from the above table.

The Pointers in the Dipper are α and β Ursae Majoris. As their R.A.'s differ they only approximately point to the N. Pole.

The Pointers α and β of the Square of Pegasus point approximately in an opposite sense to the Dipper Pointers. Produced southward they locate Fomalhaut.

From ηUMaj, the tip of the Big Dipper handle, in two nearly equal steps, are Arcturus, then Spica, in a broken line.

From Aldebaran through Orion's Belt to Sirius one passes in two nearly equal steps.

Line up Castor, Betelgeux, Alnilam, Rigel, taking the steps from the table.

Line up Castor, Pollux, Alphard; also Alphard, Sirius and β Canis Majoris; also Alpheratz, Markab and α Aquarii.

Note that the proof of good alignment requires that the intermediate angles add up to the angle between extremes, e.g., Alpheratz − Markab = 20°12′; Markab − α Aquarii = 21°18′; Alpheratz − α Aquarii = 41°30′. Few lines are as true as this.

Line up βDrac 4°07′, γDrac 27°22′, γCygn 31°29′; βDrac. Also Arcturus—βCorB—Vega. The line Mizar, Alkaid, Arcturus, is broken.

Another line is N. Pole—Mizar—Spica.

Note also Polaris—N. Pole—Alkaid. See elsewhere the use of this line in pointing to the N. Pole.

In Orion's Belt, $\delta\epsilon = 1°23'.2$, $\epsilon\zeta = 1°21'.3$, $\zeta\delta = 2°44'.3$. The eye detects this as a broken line.

The stars α, β, γ of Andromeda and α Persei provide a curving handle to the Square of Pegasus, converting it into a saucepan.

Attention is also drawn to the following:

N. Pole—Caph—Alpheratz.
ζOrio—Procyon—Regulus.
αSerp—δOphi—ζOphi.
Mizar—Polaris, across the pole to δCass.
Capella—βTaur—Betelgeux, a broken line.
Arcturus—Denebola—Regulus, a broken line.
The γ—α—β line in Aquila.

Some Figures

The Square of Pegasus, αAndr with β, α, γPegs, has an area of 3.62 spherical degrees, nearly one per cent. of the hemisphere.

The approximately equilateral triangle, Betelgeux, Sirius, Procyon, has an area of 5.34 spherical degrees.

The triangle Vega, Deneb, Altair, has 7.14 spherical degrees' area.

The triangle of Hamal, Alcyone, Menkar, has sides of 23°.

Sirius, Betelgeux, Aldebaran, Rigel form a trapezium enclosing Orion, of which Betelgeux-Rigel is the short diagonal.

Capella-Vega, 93°20′ apart, are on the two hands, when one faces north.

The stars α, γ, δ, β form the trapezium in Leo.

From the above table, twenty-two triangles may be formed which are nearly isoceles, in each of which two sides differ by less than a degree.

The Little Dipper spills into the Big Dipper.

Some curves are Corona Borealis; the Sickle in Leo; the strange curves in the Scorpion; the $\gamma\alpha\delta$ arc in Perseus, indicated by $\gamma\delta$ of Cassiopeia.

There is a cross, of a sort, formed by $\alpha\beta\gamma\delta\epsilon$ in Cygnus. For the Southern Cross, see α Crucis in the table.

We have left the area of the Dipper Bowl to the reader's curiosity, as also that of the "Cutter's Main Sail" in Corvus.

Here are added some objects for examination with a small telescope: The nebula in Andromeda, some 8° in advance of β Andromedae; the open cluster Pleiades in Taurus (see table for Alcyone); the Hyades; δTauri is 3°16′ from Aldebaran; the globular cluster between ζ and η Herculis—this is in the line Vega-Alphecca, at 23° from Vega; the nebula in Orion's sword, θ Orionis, in the nebula, is 4°17′ south of ζ Orionis, most easterly star in the Belt; the double stars, of which Mizar, and γ Leonis are suggested from many. The latter, γ Leonis is in the Sickle, 8°21′ from Regulus. Mizar, of 2.4 magnitude, is ζ Ursae Majoris. Its companion, of 4th magnitude, is 14″ of arc distant. The small star, Alcor, seen with the unaided eye near Mizar, of course is not in this partnership.

May we say in closing that the general star maps may not be used for scaling the angular distances between stars. A sphere cannot be "developed". Nor can these angles be taken from a small globe with any precision. Conversely, the angles given will not build up a map. The drawing of vignettes with faint R.A. and Dec. lines, and plotted magnitudes, is a fine art.

Faculty of Engineering,
McGill University, Montreal, May, 1940

AWARD OF COMET MEDAL TO LEWIS V. SMITH

By J. W. Campbell

The Publications of the Astronomical Society of the Pacific, Vol. 52, p. 54, contain the following announcement:

"One Hundred and Seventy-first Award of the Donohoe Comet Medal

The Comet Medal of the Astronomical Society of the Pacific has been awarded to Lewis V. Smith, of Sedgewick, Alberta, for the discovery of an unexpected comet on April 16, 1939.

W. H. Wright,
S. Einarsson,
H. M. Jeffers,
Committee."

The story of the discovery of this comet, Comet 1939d, is of some interest. The comet medal committee lists ten independent discoverers as follows:

	Discoverer	*Place*	*Time* (U.T.)
1.	Jurlof	Votkinsk, U.S.S.R.	April 15
2.	Achmarof	Balesino, U.S.S.R.	April 15
3.	Lewis V. Smith	Sedgewick, Alberta	April 16, 4^h5
4.	Olaf Hassel	Hokksund, Norway	April 16, evening
5.	E. W. Barlow	England	April 18
6.	E. Buchar	Prague	April 18, 19^h
7.	Kosik	Aschabad, U.S.S.R.	April 19, 15^h
8.	C. L. Friend	California	April 19
9.	Roger Rigollet	France	April 20, 21^h
10.	Okakayasi	Tokyo	Date unknown, but probably after April 20.

The announcement of Hassel was the first one distributed, and the next received at a central bureau were those of Jurlof and Achmarof. Mr. Smith observed the comet on a Saturday evening, wrote a letter on Sunday which was received at the University of Alberta on Wednesday. It was thus almost four days after his discovery before his letter was received in Edmonton.

The committee reports that "by more or less general consent, a comet shall have no more than three discoverers' names as part of its formal designation, and . . . on this basis Comet 1939d

is now known by the names of 'Jurlof-Achmarof-Hassel'." They stated, however, that Mr. Smith's discovery is likewise worthy of recognition.

Two days elapsed between the discovery of Hassel and that of the next observer on the above list. Accordingly, the committee decided that the Donohoe Comet Medal should be awarded to Messrs. Jurlof, Achmarof, Smith and Hassel.

It is regrettable that due to an unfortunate delay in Mr. Smith's communication his name is not included in the comet's designation, but it is gratifying that his discovery has been recognized by the award of the Donohoe Medal.

University of Alberta,
Edmonton, Alberta.

THE FUTURE OF THE EARTH*

By C. S. Beals

TO an observer outside the solar system the telescopic appearance of the earth would be in no way remarkable. It would simply look like an insignificant member of the sun's family of planets. To us, its inhabitants, however, the earth is of supreme importance because it is not only our home but it will be the home of the human race for ages to come. For this reason the future of the earth holds an interest for us which could not possibly attach to any other heavenly body.

In thinking of the future of the human race it does not usually occur to us to question the permanence or stability of physical conditions on the earth's surface. If we are thinking in terms of thousands or even hundreds of thousands of years this is a perfectly logical attitude to take as there is no reason to expect any drastic changes in earthly conditions during such relatively short periods of time. If, on the other hand, we are dealing with such periods of time as are commonly associated with the lifetime of a star like our sun, then we must definitely face the possibility that a time will come in the far distant future when conditions on the earth will be so altered that human beings like ourselves will no longer be able to survive.

There are a number of things which might happen to the earth to make it uninhabitable for human beings. Some of these things are in the nature of accidents. Others are continuous processes which we know to be going on at the present time even though we may not be able to predict with certainty their final results. We will begin with some of the least alarming of these various possibilities.

One thing which might happen is a collision of the solar system with a passing star. The stars are bodies like our sun and since some of these bodies are moving in our direction it is possible that some time in the future we might collide with one of them. Such a collision could either destroy the earth completely or remove it from the vicinity of the sun so that we would no longer have an adequate source of light and heat. Fortunately we are able from our knowledge of the motions and distances of the stars to calculate the mathematical

*A radio address over Station CFCT, Victoria, B.C., February 5, 1940.

probability of such a collision occurring and it turns out to be so extremely remote that we can for all practical purposes dismiss it from our minds.

Another possibility is a change in the size or shape of the earth's orbit due to the disturbing effects of the other planets. Every time the earth passes another planet in its revolution around the sun its orbit is very slightly distorted by the gravitational force acting between them. These distortions are exceedingly small and in general they tend to balance out, but it is possible that their cumulative effect over a sufficiently long time could produce appreciable changes in the earth's orbit. If these changes were large enough we might find ourselves either too close or too far from the sun. In either case the changes in climate might be too drastic for human life to survive. This possibility is in much the same category as the preceding one. It is too remote and too uncertain for us to take it very seriously in a discussion like this.

Still another possibility, and one which has received a great deal of scientific and popular attention, is the danger of a collision with our own satellite, the moon. As long ago as the beginning of this century the English scientist, Sir Charles Darwin (not the biologist) showed that the tides caused by the moon are lengthening the day by 1/1000 of a second per century and that this process will cause the day to grow longer and longer until it is equal to the length of a lunar month. At the same time the moon is getting gradually farther and farther from the earth. When the day and the month are of equal length the moon will have reached its maximum distance from the earth. When this state has been reached the tides due to the sun will act to still further increase the length of the day. The moon will then begin to approach the earth. This approach will continue until the moon is only a few thousand miles away and even though they would probably not crash together the disturbances in the earth's surface due to a close approach by such a massive body as the moon would have a very serious effect on any form of life which might be present. The moon itself would probably be shattered to fragments and possibly form a ring around the earth, such as that of Saturn.

We have very good scientific evidence that the first cycle of the above process is actually going on. It is, however, an exceedingly slow process, so slow in fact that the end for life on the earth would

probably have come by some other means before the second cycle is completed.

Probably the most sensational occurrence which we could imagine in our solar system is a sudden large increase in the brightness of the sun. Such sudden increases in brightness are known as nova outbursts and among the stars in our galaxy it is estimated that there have been about 4,000 such outbursts during the present century. In the ordinary nova outburst the star increases in brightness about 10,000 times during a very few days and then slowly fades and resumes its former brightness. It is unnecessary to point out that such an outburst by the sun would be completely fatal to life on the earth. Even a tenfold increase in the sun's light and heat would probably destroy all life and an increase of 10,000 times might even reduce the surface layers of the earth to molten lava.

When we come to size up the probability of such an event occurring, again we find very little to cause alarm. If we suppose that every star is equally liable to a nova outburst, then such an accident might happen to the sun every two hundred million years or so. Recent studies have shown, however, that nova outbursts probably only occur to certain special kinds of stars with characteristics very different from those of the sun. This enormously decreases the chances of such a happening, so much so that we may largely disregard this possibility.

A source of danger to our race which should be taken more seriously than any of those already mentioned is a change in the chemical constitution of the earth's atmosphere. We know that the atmosphere is constantly losing oxygen by chemical combination with surface rocks which contain iron compounds. The resulting oxide of iron, familiar to us as iron rust, is responsible for the yellow sands of the Sahara, the red rocks of the painted desert and even the red clays of the ocean depths. While undoubtedly most quantities of oxygen have been lost to the atmosphere in this way there is also going on a process of replenishment due to the action of volcanoes. Volcanoes give off large quantities of carbon dioxide and by the action of sunlight on green plants, a great deal of this carbon dioxide is broken up and free oxygen released to the atmosphere. Thus nature is acting to maintain equilibrium and it may be that this equilibrium can be maintained indefinitely. On the other hand, it

is possible that the process of replenishment will eventually break down and, if this takes place, a steady loss of atmospheric oxygen will result. There is some reason to believe that this process has been carried to its logical conclusion in the case of the planet Mars. The spectroscope tells us that the atmosphere of Mars is very poor in oxygen and the red colour of the planet suggests that the oxygen formerly present in its atmosphere has practically all been taken up by the surface rocks. It is possible though we hope not probable, that the earth is headed for a similar fate.

The various possibilities which we have outlined for the destruction of life on the earth all have a question mark associated with them. There is no certainty that any one of them will have a sufficiently drastic effect to seriously impair the habitability of the earth. It almost looks then as though the earth can be regarded as perfectly safe and that conditions favourable to life will last indefinitely. Unfortunately, we cannot take quite such an optimistic view. There remains one process which is going on slowly and relentlessly, and which we believe will finally transform our planet into a cold and lifeless place. This process, as you have probably already guessed, is the gradual exhaustion of the sun's light and heat.

The sun is radiating away light and heat at a rate so enormous that it becomes almost meaningless when expressed in cold figures. We on the earth receive only one part in twenty-two hundred million of this great stream of radiation, and most of the remainder is lost in the depths of space. The most elementary knowledge of physical processes tells us that this outburst of energy cannot go on forever. The only question in our minds is how long can the sun maintain approximately its present brightness. The answer to this question depends upon the source of the solar energy and the nature of this source has been the subject of a great deal of intensive study during the past few decades. There now seems to be general agreement that th eenergy source is to be found in the actual transformation of the mass of the sun into radiation. The details of this process are still obscure and it is still uncertain what proportion of the sun's mass is available as the fuel to provide light and heat. Most of the theoretical work done on this problem has been based on the assumption that a considerable proportion of the mass can be used for this purpose. In any case we know that the transformation of mass into radiation is

such an extraordinarily rich source of energy that a loss of one thousandth of its mass would be sufficient to keep the sun shining for a billion years or more. Actually ten billion years is probably a conservative estimate of the time during which we can depend on the sun to provide the earth with adequate light and heat.

Such a time scale should be sufficient to satisfy anyone, however great may be his faith in the destiny of the human race. A period of time approximately a million times as great as the span of recorded history is surely great enough for our race to rise to its fullest possibilities and perhaps great enough to see its decline and death from inherent weaknesses which are not now apparent. In any case, this time scale presented to us by modern astrophysical researches gives us an inspiring vista of the future and one which may help to reconcile us to lagging progress during our own times.

Dominion Astrophysical Observatory,
Victoria, B.C.

METEOR NEWS

Observations relating to meteors and meteorites are cordially invited.

Leonid and Geminid Observations at Ottawa, 1939

By Miriam S. Burland and Malcolm M. Thompson

Amateur observations of the Leonid and Geminid meteors at Ottawa in November and December, 1939, were carried on from the roof of the Dominion Observatory. Six people participated in a total of 14 hours over a period of six nights. On two of these

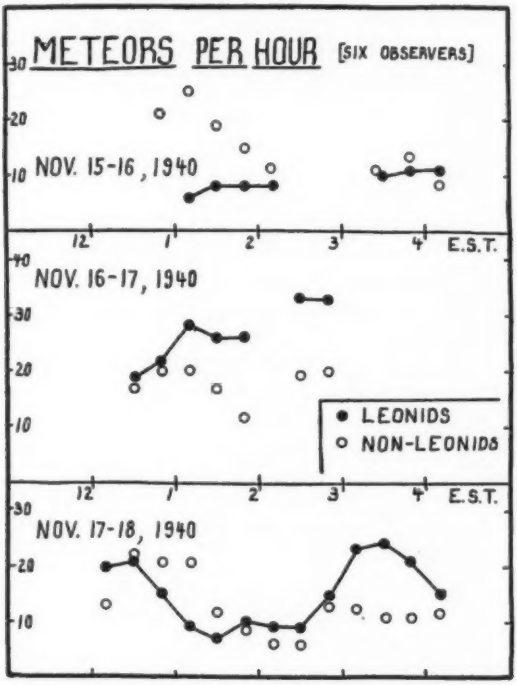


Figure 1—Visual meteor rates of the Leonid meteors as observed at the Dominion Observatory, Ottawa.

TABLE I

VISUAL OBSERVATIONS IN OTTAWA OF THE LEONIDS AND GEMINIDS, 1939

Date	E.S.T.	Meteors		No. Observers	Weather Factor
		Shower	Non-Shower		
Nov. 15–16....	12.25—4.09	12	29	2	9
16–17....	12.20—3.20	50	34	3	4
17–18	11.40—4.20	55	51	4	9
Dec. 11–12	12.00—1.40	27	15	2	9

MAGNITUDE DISTRIBUTIONS

	−4	−3	−2	−1	0	1	2	3	4	5	Total	Mean Mag.
Leonids.....	1	2	6	20	26	21	20	7	9		112	0.7
Non-Leonids.....		2	2	1	20	21	21	20	24	2	113	1.9
Geminids.....		1		3	5	5	6	3	4		27	1.3
Non-Geminids.....					2	7	5	1			15	1.3

TABLE II

PHOTOGRAPHIC OBSERVATIONS, OTTAWA, OCT.–DEC. 1939

	Date	Total Exposure Time	Meteors Photographed	Weather Factor
Spectro-photography	Oct. 22–23	0.2 hrs.		2
	Nov. 15–16	3.0	1	9
	16–17	2.0		4
	17–18	3.8		9
	Dec. 11–12	1.0		9
	Totals	**10.0**	**1**	
Direct Photography	Nov. 15–16	6.1	1	9
	16–17	4.4	1	4
	17–18	3.7	1	9
	Dec. 11–12	1.0		9
	Totals	**15.2**	**3**	

nights, cloudy skies prevailed. A summary of the visual observations is given in Table I. The rates, reduced to six observers, are shown diagrammatically in Figure 1.

Photography was carried out with two cameras with no attachments, and a third equipped with a 30-degree prism and a rotating shutter which allowed 10 exposures a second. One faint spectrum of a Leonid was secured. This shows two segments and is of Type Y. Three direct photographs were obtained, two of Leonids and one of a sporadic meteor. The photographic programme is summarized in Table II.

These results, both photographic and visual, were obtained only by reason of the enthusiasm of those who were undaunted by zero weather. Those who assisted the writers in the observations were Messrs. Emile Potvin, Stanley A. Mott, Samuel Palef, and Walter Krzyzewski. Thanks for the loan of cameras are due to Miss P. Whitehurst and Mr. John Cole, and for the loan of a prism to Mr. Wm. Hill, optometrist.

Dominion Observatory,
Ottawa, Ont.

Meteor Shower Observations in Orillia, October 1939–April 1940

Our meteor observer in Orillia, Mr. Jack Grant, has carried out a very consistent series of observations of all the well-known meteor showers during the past winter and spring. He is to be congratulated upon his success in meteor photography which, to the best of the writer's knowledge, constitutes a record for amateur work in this field. Using four direct cameras Grant secured 28 photographs of meteors over a period of four months in a total exposure time of 180 hours near shower maxima. This is an average of one meteor photograph for each six and a half hours of exposure. Since Mr. Grant obtained 7 meteor photographs during the Perseid shower in 1939 his total is 35 meteor photographs for the six months August 1939 to January 1940. These meteors were from the following radiants:—Perseids 7, Orionids 5, Leonids 11, Geminids 9, Quadrantids 1, Non-Shower 2. This record demonstrates the fine results which are possible through persistent effort. Since August of 1936 Grant has contributed a total of 58 meteor photographs. This is a very worth-while and important contribution

to the study of meteors and we are looking forward to a continuation of this good work in the future.

A summary of the work carried out in Orillia will be found in Table III. The first four columns give the results of the photo-

TABLE III

METEOR OBSERVATIONS BY JACK GRANT, ORILLIA

Date (1939-40)	No. Exposures	Total Exposure Time	Meteors Photographed	Visual Observations		Weather Factor
				Shower	Non-Shower	
Oct. 9–10	11	5.8 hrs				3
20–21	36	16.4		3		5
21–22	51	19.2	5	17		9
22–23	10	2.2		1		4
Nov. 14–15	25	14.8				10
15–16	38	20.1	2	4	1	10
16–17	30	13.8	9	6	1	10
17–18	26	15.3	1	5	1	7
Dec. 10–11	20	12.7			2	8
11–12	39	23.8	2			7
13–14	43	26.8	8	10	1	8
Jan. 1– 2	9	2.4		1		5
2– 3	1	0.2				3
3– 4	9	3.0	1	5	3	7
Apr. 22–23	21	3.7				5
Totals	369	180	28	52	9	

graphic programme. Owing to the time consumed in looking after the cameras visual observation was carried out only sporadically and just the bright meteors seen were recorded. The numbers of meteors so recorded and plotted are listed in the fifth and sixth columns of the table.

OBSERVATIONS OF THE GEMINID METEORS, 1939

Observations of the Draconid and Geminid showers were planned at the Dunlap Observatory in 1939 but only part of one night was clear near these maxima. On this night, December 11-12, four spectrographs and two direct cameras equipped with a rotating shutter were operated by the writer at the Dunlap Observatory. Mr. S. C. Brown exposed one spectrograph and two

direct cameras on the grounds of Pickering College in Newmarket, Ont. He was assisted by Mr. Harvey Ward and members of the camera club of Pickering College. A summary of the observations at these two stations is given in Table IV. One faint Geminid

TABLE IV

GEMINID OBSERVATIONS, DEC. 11–12, 1939

Visual Observations

Station	No. Observers	E.S.T.	Total Minutes Observed	Meteors		Reduced Rates (six observers)		Weather Factor
				G	N	G	N	
D.D.O.....	1	9.30–12.30	90	12	8	28	19	7
Newmarket.	2	9.00– 1.00	240	42	9	27	6	7

Photographic Observations

	Station	Total Exposure Time	Meteors Photographed	Weather Factor
Spectro-photography	D.D.O.	14.9 hrs.	1	7
	Newmarket	3.9		7
Direct Photography	D.D.O.	7.3	1	7
	Newmarket	7.2		7

spectrum of Type Y was photographed at the Dunlap Observatory. A direct photograph of the same meteor was also secured. This Geminid was one of those photographed by Grant at Orillia in the observations reported above so that it will be possible to compute an accurate photographic height in this case.

METEOR SPECTRA—LIST VI

In the past it has been the writer's custom to publish annually a list of all meteor spectra photographed during the past year, assigning to each spectrum a chronological number for convenience in reference. List V (JOURNAL R.A.S.C., vol. *32*, p. 357, 1938) contained the three spectra photographed in 1937. I have no information that any meteor spectra was secured in 1938, so no list was published for that year. List VI, found below, gives

details of the six meteor spectra known to have been photographed in 1939. As will be seen, four were obtained in Canada and two in the United States. All except XLVII and XLVIII were faint and contained little detail. List VI brings the total so far photographed up to fifty-one.

PHOTOGRAPHIC METEOR SPECTRA—LIST VI

Spectrum	Date	Place	Identification
XLVI	1939, Aug. 10	Ottawa, Ont.	Perseid
XLVII	" Aug. 12	Richmond Hill, Ont.	Perseid
XLVIII	" Oct. 20	University, Va.	Orionid
XLIX	" Nov. 16	Ottawa, Ont.	Leonid
L	" Dec. 11	Richmond Hill, Ont.	Geminid
LI	" Dec.	Ft. Worth, Texas	Geminid

The Ottawa spectra were both faint and of Type Y. The first was reported in the JOURNAL for this year (vol. *34*, p. 128, 1940), and reproduced in Plate VI. The second is reported above. Spectrum XLVII was also described on page 128 of the JOURNAL and reproduced in Plate VI. Spectrum XLVIII of Type Y was photographed by Dr. A. N. Vyssotsky, of the Leander McCormick Observatory, University of Virginia. It was described by him in a note in Ap. J., vol. *91*, p. 264, 1940. He measured 16 lines, identifying the elements Ca^+, Ca, Fe^+, Fe, Mg^+, Mg, Si^+, Cr, and Mn. Higher excitation than that found in most spectra was indicated and the lines of higher excitation potential were found to increase greatly in relative strength near the end of the photographed path. It is interesting to note that the present writer found Spectrum XLVII also of high excitation with the short wavelengths much stronger near the end of the path. Spectrum L is reported above. The last item on the list, Spectrum LI, was secured by the Texas Observers at Las Estrellas Observatory, Ft. Worth. This raises the total score of this active group of observers to seven spectra out of the total of 51 so far photographed. The writer learned of this spectrum through correspondence with Mr. Oscar Monnig but so far has no further details concerning date or type.

I would very much appreciate hearing of any additional meteor spectra which have been photographed and have not yet been included in these lists.

P. M. M.

REVIEW OF PUBLICATIONS

The Masses of the Stars, with a General Catalogue of Dynamical Parallaxes, by Henry Norris Russell and Charlotte E. Moore. 236 pp., 6¾ x 9½ inches. The University of Chicago Press. Price $3.50.

This monograph is a detailed and masterly presentation of all that is known about the masses of the stars. It is distinctly a research publication, not a text. There are three main sources of data which yield information about the masses of the stars, all of which concern their gravitational effects. These are the orbits and parallaxes of visual binaries, or the separation and motion of physical pairs with known distances if the orbits are not known, the periods and velocity curves of spectroscopic binaries and the periods and light curves of eclipsing binaries.

The last of these gives direct determination of individual masses and for the available data these are listed. The first, when the orbits are known, will give individual masses if the parallax is known, but as the result is much affected by errors in the parallax we have to be content with averages for most of the orbits. For those stars for which orbits are not known averages alone can be obtained. The monograph is therefore largely concerned with the average masses and there is an extensive investigation in order that the averages may be free from statistical error.

Visual double stars, for which motions but not orbits are available, comprise the greatest amount of data. On this account a discussion of the dynamical parallaxes or the parallax on the assumption of unit mass comprises a large part of the monograph.

The masses of the white dwarfs as a class are not treated. The monograph is a most valuable contribution and should find a place in all observatories and astronomical libraries.

R. K. Y.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Cancellation of Anniversary Meeting of the R.A.S.C.

At a meeting of the General Council of the Royal Astronomical Society of Canada, held on July 5, 1940, it was decided to cancel the special meetings that had been planned for the late summer to celebrate the semi-centennial of the founding of our Society, and the centenary of the founding of the first observatory in Canada. For such meetings to fulfil their purpose, it would be important to have delegates from all the centres. It was felt that the war conditions would make it unwise to undertake the great effort and expense that would be involved in making such a meeting a success.

A New Astronomical Observatory in New Zealand

From Bulletin No. 1 of the Carter Observatory, we reprint the following information:

By legislation in the New Zealand Parliament the Carter Observatory was established in 1939. It is financed by a bequest of the late Charles Rooking Carter (left in 1896) and by grants from the Government and the Wellington City Council. It is controlled by a Board, elected in accordance with the provisions of the "Carter Observatory Act, 1938".

Astronomical work (except the time service) formerly carried out by the Dominion Observatory, Wellington, is now undertaken by the Carter Observatory. The Wellington City Observatory has ceased to exist, having been merged into the new observatory.

The equipment consists of a 9-inch photo-visual equatorial refractor, with spectroscope and filar micrometer as accessories. It is hoped to mount later a 20-inch mirror given to the Observatory by Victoria University College. Two auroral cameras, on loan from Professor Störmer of Oslo, are operated by volunteer observers in the South Island. A spectrohelioscope, on loan from the Mt. Wilson Observatory, will be set up as soon as practicable.

At present the observatory is a temporary structure, but preparations are being made for the erection of a substantial building in the very near future.

The staff consists of M. Geddes, M.A., F.R.A.S., Director, and I. L. Thomsen, F.R.A.S., Assistant.

It is intended to issue these bulletins monthly and to include in them reports on the general routine work of the observatory. In addition reprints of papers will be issued from time to time.

In all cases times are U.T.

Conference on Science, Philosophy and Religion

In November, 1939, a meeting of ten eminent scholars was held in New York "to consider the proposal for the establishment of a continuing conference to bring about a better understanding between science, philosophy and religion, and to show how their integration may contribute to the advancement of democracy." Physical Science was represented by Professor Arthur H. Compton, of Chicago, and Professor Harlow Shapley, of the Harvard Observatory. A Conference has been arranged, with these ten scholars as an advisory committee, and with eighty-one outstanding men of science, philosophy, and religion as founding members.

A preliminary announcement of the Conference includes the following information:

Origin.—The founding members of the *Conference on Science, Philosophy and Religion in Their Relation to the Democratic Way of Life* realize that today civilization itself is threatened by the rise of totalitarian systems based on anti-scientific, anti-philosophic, and anti-religious dogmas; that Science, Philosophy and Religion can survive only in a world which respects the human worth of the individual; and, at the same time, that each of these traditions can make a contribution to the concept of universal human worth. They believe further, that the departmentalization of thought in democratic societies has been in part responsible for the weakness of democracy in the face of totalitarianism. Clearly the time has come when those who are helping to fashion an American way of life should try to meet one another, to reach a mutual understanding, and if possible to formulate the basis on which they may cooperate for the preservation of democratic ideals.

Programme.—These meetings will be held on Monday, Tuesday, and Wednesday, September 9, 10, and 11, 1940, at the Jewish Theological Seminary of America, New York City, when various scientists, philosophers and theologians will present papers for discussion at four sessions to be devoted to The Social Sciences, Philosophy, The Natural Sciences, and Religion and the Philosophy of Education. These papers and the discussion will be published as a symposium on the subject of "Science, Philosophy and Religion in Their Relation to the Democratic Way of Life." The assembly of eminent men in the fields of education, philosophy, science and theology, to discuss the integration of their interests, will doubtless stimulate further thought regarding the problem, and the initial symposium will form an impressive contribution to American thought.

It is expected that this Conference in September will serve as the first step toward a more general project, looking to the integration of Science, Philosophy and Religion.

F.S.H.

MEETINGS OF THE SOCIETY

AT WINNIPEG

January 10, 1940.—The regular meeting of the Royal Astronomical Society of Canada, Winnipeg Centre, was held in Theatre "F." of the University of Manitoba. Mr. L. J. Crocker was in the chair.

The following were elected to membership in the Winnipeg Centre:

Mr. Geo. Frith, 444 Furby St., Winnipeg.
Miss L. Gray, Ste. 6, Cambridge Apts., Winnipeg.
Mr. John A. McLean, 415 Scotia St., Winnipeg.
Mrs. H. Ross, Ste. 17, Congress Apts., Winnipeg.

The speaker of the evening was Prof. Harold F. Batho of the University staff. His subject was, "The Stratosphere."

He began by saying that public interest and general scientific interest dates from the spring of 1931 when Auguste Piccard took the first stratosphere balloon up to an elevation of 9.81 miles, or almost 3 miles into the stratosphere. Valuable scientific knowledge was brought back, but greater interest was aroused by the mishaps and nearly disastrous ending. Eleven flights into the stratosphere during the next five years supplied equally good news items.

The existence of the stratosphere was recognized as early as 1898. Teisserenc de Bort, a French meteorologist, was one of the pioneers in this connection as were also Lindemann and Dobson in England. Aeroplane flights have furthered our knowledge and radio has added more.

To-day interest centres in the subject because of five sciences: (1) Weather forecasts, (2) Aviation, (3) Astronomy, (4) Radio, (5) Physics; also the last sphere for human exploration is the stratosphere. Each of these topics was dealt with in detail.

Descriptions of Piccard's first flight in 1931 and the two "Explorer" flights, in 1934 and 1935, which were sponsored by the National Geographic Society, followed.

Fairly definite conclusions have been reached. The stratosphere is an isothermal zone whose temperature is constant at -60° F. to -80° F.—independent of season and latitude. Its barometric pressure is very low. The sky up there is dark blue. The sun is 20% brighter, with excess ultra-violet rays. There are no clouds or electrical storms. There is great cosmic ray activity and great electrical conductivity. There are free floating spores and probably strong but steady winds.

Further information is needed to confirm previous deductions and increase our knowledge about cosmic rays, meteorology and radio.

Aviation seems certain to benefit soon from the present information. Flying would be simplified in a region of reduced air-resistance, perfect visibility,

no electrical storms, no icing and probably no wind storms. Sealed and heated cabins would solve the problems of respiration, body pressure and temperature. A super charger for the motor and a propeller which has a variable pitch would make air travel cheap and 30% faster than is now possible.

March, 1940.—A regular meeting of the Winnipeg centre of the Royal Astronomical Society of Canada was held in theatre "F" of the University of Manitoba. The president, Mr. C. J. Crocker, was in the chair. A new member, Mr. W. P. Johnson, was welcomed to the society. Mr. R. D. Colquette gave a most interesting ten-minute talk about "Astronomy in the News."

The speaker of the evening, Rev. Father Burke-Gaffney, Professor of Astronomy, St. Paul's College, chose for his subject, "Kepler, a Seventeenth Century Genius." He gave an intimate, detailed description of Kepler's life and work in those stirring times of religious prejudice and scientific development.

An interest in astrology led Kepler to keep a minute diary of his family affairs so that the happenings could be compared with the positions of the planets and stars. From this diary we learn that his home was a poor one. Johann, who was born in 1571, was delicate. The father was a soldier and eventually a tavern keeper who went bankrupt. When this happened Johann was sent to a state school as a pauper. A brilliant mind and hard work earned scholarships to enable him to continue his education. He showed marked mathematical ability, studied astronomy, wanted to study theology, but graduated in philosophy.

His first work, "Cosmographic Mystery", brought him acknowledgment from Galileo and Tycho Brahe.

When other Protestant teachers and preachers were expelled from Styria, Kepler was allowed to remain. Two years later, in 1600, Kepler was appointed assistant to Tycho Brahe in Prague. When his superior died in a year's time Kepler fell heir to all of Tycho's instruments and records and was appointed imperial mathematician.

By studying the tables of refraction which he had received from Tycho he was able to write of the optical side of astronomy. This led to the study of the eye and optics. When in 1606 he saw a nova he tried to explain the Star of Bethlehem as a star of this type. In 1607 he saw and described the comet which was afterwards known as Halley's comet. His laws of planetary motion followed. Work on dioptrics was the forerunner of the modern refracting telescope.

He died in 1630, after having published 45 works, 26 of these were of astronomy, 6 of chronology, 5 of astrology, 5 of mathematics, 2 of optics, and one of theology. Eight were written in German and 37 in Latin, and there were almost as many more unfinished.

He would truly have been acknowledged as a genius in any century.

OLIVE A. ARMSTRONG, *Press Reporter*

AT OTTAWA

January 19, 1940.—On Friday, January 19, at 7.30 p.m., the Royal Astronomical Society of Canada, Ottawa Centre, joined forces with the residents of Rockcliffe Park, and on the invitation of the Public School Board, held an open meeting in the public school hall. Mr. Hoyes Lloyd, who is both a member of the school board and also a councillor of the local R.A.S.C., served as chairman for the evening, and introduced the speaker, Mr. C. C. Smith. About 150 people were present, nearly half of whom were young people of school age.

Under the title "Stars and Clocks", Mr. Smith spoke of his early association with the Time Service of the Canadian Government, his first work having been done in a small hut on Cliff Street 37 years ago. Time keeping in those days was very crude compared to the refined methods used today. Our units of time were explained, the year and the day, a globe and flashlight being used to illustrate these two motions. The same model served to explain why there are different times across Canada. The work of Sir Sanford Fleming in creating Standard Time Zones around the world was described, and a map showing the time zones across Canada illustrated the change of time from east to west in seven hours.

Time, of course, is determined by measuring the length of the day with reference to the stars because they are mere points of light in the best of telescopes. The sun is too large with too indefinite an edge to serve as a point source, and besides the length of the day with reference to the sun is not the same from one time of the year to another. An average day is chosen in which a ficticious sun apparently moves with great regularity the year round. At times this imaginary sun which marks the hours of the day is as much as a quarter of an hour different from the actual sun.

Time is measured with its starting point at the Vernal Equinox, that point in time when the sun crosses the equator on its journey northward. This is the period in the spring when days and nights are of equal length.

A telescope is necessary for the determination of the time, and with it must be a clock to mark the hours during the day. Slides illustrated the telescopes and precision clocks in use at the Dominion Observatory at Ottawa. And finally the distribution of correct time was illustrated by showing a picture of the new Time Machine devised by the Dominion Astronomer, Mr. R. Meldrum Stewart. By it, time is sent over the telephone, the telegraph, and the radio, so that people right across the Dominion of Canada are able to know the correct time.

After the indoor meeting, three telescopes were set out at the south end of the building under the care of Mr. J. P. Henderson, Mr. M. M. Thomson, and Miss Miriam S. Burland. In spite of the near zero weather, it was nearly an hour before the last person turned reluctantly away from the views of the moon and the three planets, Mars, Jupiter, and Saturn. It was a stroke of good luck that clear skies favoured such enthusiasm.

M. M. Thomson, *Secretary.*

The Royal Astronomical Society of Canada

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